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Separates of the paper by Margaret Cooper: *Bibliography and index of literature on uranium and thorium and radioactive occurrences in U. S. Part 3: Colorado and Utah* will be available *after* July 1. Price 50 cents. Remittance should accompany order.

BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA
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BIBLIOGRAPHY AND INDEX OF LITERATURE ON URANIUM AND THORIUM AND RADIOACTIVE OCCURRENCES IN THE UNITED STATES

PART 3: COLORADO AND UTAH

BY MARGARET COOPER

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FOREWORD

The following bibliography consists of references to published literature, press releases, speeches, and both open-file and other unclassified reports dealing with uranium, thorium, and radioactive occurrences in Colorado and Utah. It is Part 3 of a comprehensive bibliography planned to cover references to all similar deposits throughout the world. While the object has been to make the present bibliography as all-inclusive as possible, from the point of view of including all the major papers and at least one reference to each known radioactive occurrence in these two States, only references for which the original text was readily available for examination and checking have been cited at this time. The remaining old and new references will be added to this basic list when the section is ready for inclusion in the comprehensive volumes, planned for future publication as a complete bibliography of the entire United States and world.

The main bibliography consists of an author section, in which each reference has been assigned an individual item number. Following the author listings are the anonymous notes, which are listed in chronological order, and alphabetically by title within each year. The bibliography proper is followed by three indexes: Index I, Gazetteer for Colorado and Utah; Index II, Geographical Index for Colorado and Utah; Index III, Subject Index for Colorado and Utah. The geographical and subject indexes have been made as detailed as practicable since the main reference entries have not been annotated. Where there are variations in spelling or alternate names for the same locality, a standard form has been used in the geographical and subject indexes and the variations have been noted in the gazetteer. Where county boundary lines have been changed since a reference was written, the locality has been listed under the county in which it is found today.

Entries for certain mines and prospects in Boulder, Chaffee, Clear Creek, El Paso, Gunnison, Jefferson, and Larimer counties, Colorado, and Beaver, Piute, and San Juan counties, Utah, are cited frequently and are unusually long because they include detailed ownership and location information. To avoid needless repetition, the full description of these mines appears in the gazetteer and only in the first entry under the proper county in Index II, where the mine is mentioned. Thereafter only the name of the mine or prospect is used throughout Index II and Index III.

A fairly extensive survey has been made of the geological and mining literature published through 1949 in compiling the references included in this bibliography. A few of the standard American and English geological and mining publications have also been reviewed up to the early part of 1952. Every reference cited

in the bibliography has been checked with the original text. References re-cited from the first two sections of the bibliography, Part 1* covering Arizona, Nevada, and New Mexico, and Part 2† covering California, Idaho, Montana, Oregon, Washington, and Wyoming, have been assigned the same item number as in Parts 1 and 2. The authors and item numbers of these re-cited references have also been recorded here in regular alphabetical order in the second group of author listings, which gives all the new references on the states covered by this bibliography.

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* Hereafter cited as George Peabody claim.

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Old Quartz Hill area: 77.
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Uranium Occurrences—
General: pitchblende in more than 20 vein deposits: 455.
Colorado Front Range, rocks bordering: carnotite: 20.
Front Range Mineral Belt: pitchblende deposits with hypogene zonal distribution: 458.
Boulder County—
Caribou mine: pitchblende: 53, 102, 453, 454, 458, 468, 484.
(See also Colorado–Boulder, Clear Creek, Gilpin, Jefferson, Larimer, and Park Cos.)
Colorado Mineral Belt
Uranium Occurrences—
Lake County—
Leadville Mining District: uranium as coatings on fracture surfaces or disseminations in country rock: 477.
St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also as coatings on fracture surfaces and disseminations in country rock: torbernite and sooty pitchblende present, probably alteration products of primary pitchblende: 477.
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General: pitchblende present, probably hypogene: 477.
Lower Uncompahgre Mining District: uranium with base and precious-metal veins: 477.
Red Mountain Mining District: uranium with pyritic veins and copper-lead-silver volcanic breccia pipes: 477.
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Alma Mining District: uranium with base and precious-metal veins; pitchblende present: 477.
Colorado Plateau
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General: 63; deposits in Morrison formation stratigraphically controlled: 443; deposits in Salt Wash member of Morrison formation, scattered erratically over Arizona, Colorado, New Mexico, and Utah: 431; small, widely scattered deposits; U_3O_8 content 0.1 to 0.3%: 457; origin: 431.
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Bedded uranium deposits in Morrison formation: map showing: 486.
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Newlin (not Newlands) Gulch district 20 mi. S of Denver: monazite: 252.
Platte Canyon: monazite: 252.

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Eagle County
Carnotite Occurrences—
Brush Creek, 7 mi. SE of Eagle: 34, 82; in sandstone: 78.
Horse Mountain: silver-copper-carnotite deposit: 46.
Radioactive Areas—
Eagle mine, Gilman area: galena and sphalerite ores, sulphides: 45.
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Eagle mine, Gilman area: 45.
Uranium Occurrences—
Brush Creek, 7 mi. SE of Eagle: carnotite: 34, 82; carnotite in sandstone: 78.
Horse Mountain: silver-copper-carnotite deposit: 46.
El Paso County
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*Mike Doyle prospect 10 mi. S of Colorado Springs and just W of Colorado State Highway 115: uranium-bearing material in carbonaceous shale underlying sandstone: 402.
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Mike Doyle prospect: in Morrison sandstone as coating on fracture surfaces and on carbonized wood fragments: 402.
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Kasolite Occurrences—
St. Peters Dome: in fluorite-quartz-sulfide deposit: 504.
Uranium Occurrences—
Mike Doyle prospect: carnotite in Morrison sandstone as coating on fracture surfaces and on carbonized wood fragments: 402; geology: 402; structure: 402; three samples of carnotite showed respectively 0.09% U, 0.22% U_3O_8, and 0.27% U_3O_8: 402; uranium-bearing material in carbonaceous shale underlying the sandstone: 402; uranium deposits in Morrison formation controlled by fractures and related faults: 509.
St. Peters Dome: kasolite in fluorite-quartz-sulfide deposit: 504.
Uranium Purchases—
Colorado Springs: uranium ore-buying station: Nevada pitchblende ore purchased: 188.
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See under individual county names and under Index III, Fluorites, Uranium-bearing—Colorado: 95, 474, 475, 504.
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Allanite Occurrences—
Mica Lode Mine operated by Colorado Feldspar Co., on a conical knob in south central part of Eight Mile Park: in pegmatite with thorite, triplite: 234.
Monazite Occurrences—
Rowe's South Prospect, Micanite Mining District, E of Mac Gulch: in pegmatite: 234.
Thorite Occurrences—
Mica Lode mine operated by Colorado Feldspar Co., on a conical knob in south central part of Eight Mile Park: in pegmatite with allanite, triplite: 234.
School Section mine operated by Colorado Feldspar Co., SW part of Eight Mile Park: in pegmatite (may be triplite): 234.
Thorium Occurrences—
Mica Lode mine operated by Colorado Feldspar Co., located on a conical knob in south central part of Eight Mile Park: pegmatite with allanite, thorite, triplite: 234.
Rowe's South Prospect, Micanite Mining District, E of Mac Gulch: pegmatite with monazite: 234.
School Section mine, operated by Colorado Feldspar Co., SW part of Eight Mile Park: pegmatite with thorite or triplite: 234.
Torbernite Occurrences—
Jesus lode: or autunite and uraniferous carbonized wood in Cretaceous Dakota sandstone: 509.
Uranium Occurrences—
Jesus lode: torbernite or autunite and uraniferous carbonized wood in Cretaceous Dakota sandstone: 509.
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Monazite Occurrences—
Guffey-Micanite region: with uranothorite (?) in granite pegmatites: 403.
Thorium Occurrences—
Guffey-Micanite region: monazite, uranothorite (?) in granitic pegmatites: 403; petrology: 403.
Uranium Occurrences—
Guffey-Micanite region: monazite, uranothorite (?) in granitic pegmatites: 403; petrology: 403.
Uranothorite Occurrences—
Guffey-Micanite region: questionable occurrences with monazite in granitic pegmatites: 403.
See also Fremont Co. and under Park Co.: 403.
Gadolinite Occurrences
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Garfield County (Colorado Plateau)
Carnotite Occurrences—
General: 82.
East Rifle Creek: 34.
Rifle: 459; with roscoelite in Entrada formation: 509.
Rifle mine of U. S. Vanadium Corp. (now Co.) on East Rifle Creek 12 mi. NW of Rifle: small amounts in vanadium-bearing Entrada sandstone: 415.
Radium Occurrences—
East Rifle Creek, Rifle: radium-bearing silts: 503.
Sediments, Radium-bearing—
East Rifle Creek, Rifle: 503.
Uranium Occurrences—
General: carnotite: 82.
East Rifle Creek: carnotite: 34.

* Hereafter cited as Mike Doyle prospect.

Rifle: carnotite: 459; carnotite and roscoelite in Entrada formation: 509.
Rifle mine of U. S. Vanadium Corp. (now Co.) on East Rifle Creek 12 mi. NE of Rifle: geology: 415; small amounts of carnotite in vanadium-bearing Entrada sandstone: 415.
Uranium Processes—
Qualified Uranium Mills—
Rifle: U. S. Vanadium Co. mill: 413, 431, 497, 519; capacity of 200 t. daily reported in 1946: 440.
Uranium Production—
Rifle: U. S. Vanadium Co. mill in operation: 519.
Geophysical Exploration
See under individual county names and under Index III, Geophysical Exploration (Airborne)—Colorado: 494, and (Ground)—Colorado: 498.
Gilpin County (Colorado Front Range)
Johannite Occurrences—
Central City: 493.
Monazite Occurrences—
Central City: 11.
Pitchblende Occurrences—
Front Range Mineral Belt—
Central City Mining District—
Quartz Hill: 511; in seven mines (not named): 399; mined in commercial quantities from four gold- and silver-bearing pyrite-sphalerite-galena veins on the south side: 467; massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Alps mine: in vein deposits with gold and silver ore: 398, 460.
Belcher mine: 78, 82, 330; in vein deposits with gold and silver ore: 398, 460.
Calhoun mine: 78, 82, 397; in vein deposits with gold and silver ore: 398, 460.
East Calhoun mine owned by Realty Co. of Denver: 53; not found in mineable quantities although some was produced from 1897–1914: 467.
West Calhoun mine owned by Realty Co. of Denver: production believed small since only available figures show 240 lbs. with 37.5% U_3O_8 mined in 1912: 467.
German lode: 473.
German mine: 78, 82, 330; in vein deposits with gold and silver ore: 398, 460.
German-Belcher mine: 53.
Kirk mine: 53, 78, 82, 330, 473; in vein deposits with gold and silver ore: 398, 460; in veins found from surface through 400 ft. depth: 455.
Leavenworth mine: with gold and silver ore: 460.
Mitchell mine: in vein deposits with gold and silver ore: 398, 460.
Pewabic mine in Russell Gulch: in vein deposits with gold and silver ore: 398, 460.
Russell Gulch: analysis: 68.
Wood mine near head of Leavenworth Gulch: 53, 78, 82, 397, 473; analysis: 68; discovered in 1871: 455; in vein deposits with gold and silver ore: 398, 460; under lease to and operated by Realty Co. of Denver: assays of pitchblende ranged from .023 to 14.5% eU and from .008 to 14.27% U: 467; in vein deposits: 452.
Wood vein: assays of pitchblende ranged from .023 to 14.5% eU and from .008 to 14.27% U: 467.
Wood and Kirk mines: ore averages 0.2% U_3O_8: 394.
Wyandotte mine: with gold and silver ore: 460.
Pitchblende Production—
Front Range Mineral Belt—
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Calhoun vein in East Calhoun mine: in commercial quantities from gold- and silver-bearing vein: 467.
German Belcher vein in German and Belcher mines: in commercial quantities from gold- and silver-bearing vein: 467.
Kirk vein in Kirk mine: in commercial quantities from gold- and silver-bearing vein: 467.
West Calhoun mine: only record of production in 1912: 467.
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Front Range Mineral Belt—
Central City Mining District—
Ayres Leavenworth mine: general: 467.
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Calhoun mine: general: 467.
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German mine: general: 467.
Gold Rock mine: general: 467.
Harsh mine: general: 467.
Iron mine: general: 467.
Kirk mine: general: 467.
Pyrenees mine: general: 467.
Taylor Leavenworth mine: general: 467.
Waterloo mine: general: 467.
West Russell mine: general: 467.
Wood mine: general: 467.
Thorium Occurrences—
Front Range Mineral Belt—
Central City Mining District—
Central City: monazite, trace: 11.
Russell Gulch: pitchblende, analysis: 68.
Wood mine, Central City: pitchblende, analysis: 68.
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Front Range Mineral Belt—
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Central City: on mine faces: 493.
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Front Range Mineral Belt—
Central City Mining District—
Quartz Hill: mineralogical studies of specimens from mines and dumps in area: 445; samples collected from mines and dumps in area; polished surfaces studied: 506.
Belcher mine: 7.
Black Hawk mine: 104.

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Calhoun mine: 7.
German mine: 7.
Kirk mine: 7, 104.
Pyrenees mine: uraninite-bearing ore from dump; polished surface studied showing rather abundant uraninite: 506.
Springdale mine: uraninite-bearing ore from dump; polished surface studied showing rather abundant uraninite: 506.
Wood mine: 7, 104.
Uranium Development—
Front Range Mineral Belt—
Central City Mining District—
Quartz Hill area: 77.
Uranium Exploration—
Front Range Mineral Belt—
Central City Mining District—
Wood mine at Quartz Hill: reconnaissance investigations in 1950: 452.
Uranium Occurrences—
Front Range Mineral Belt—
Central City Mining District—
Central City: uraconite on mine faces: johannite: 493.
Quartz Hill: pitchblende: 511; in seven mines (not named): pitchblende: 399; pitchblende mined in commercial quantities from four gold- and silver-bearing pyrite-sphalerite-galena veins on the south side: 467; massive and sooty pitchblende in veins of quartz sulfide type: 455; mineralogical studies of uraninite specimens from mine and dumps in area: 445; 98% of its uranium production from Wood and Kirk mines: 394; general geology: 400; geology: 394; mineralization: 394; other ore mineralization in area: 400; principal domestic source of pitchblende, a recorded 110,757 lbs. of U_3O_8 produced there: 394; structure: 394; uraninite-bearing ore collected from mines and dumps in area, polished surfaces studied: 506; uranium ores, believed to be phase of gold-silver ores of area: 400.
Alps mine: pitchblende in vein deposits with gold and silver ore: 398, 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; structure and mineralization: 398.
Belcher mine: pitchblende: 78, 82; pitchblende in vein deposits with gold and silver ore; assays of uranium ores and concentrates given: 398; pitchblende with gold and silver ore: 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende, production: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7.
Black Hawk mine: uraninite: 104.
Calhoun mine: pitchblende: 78, 82, 397; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460; pitchblende in vein deposits with gold and silver ore; assays of uranium ore: 398; structure and mineralization: 398; mineralogy of deposit: 7; uraninite: 7.
Calhoun properties: uranium ore found above water level and on dumps: 420.
East Calhoun mine owned by Realty Co. of Denver: pitchblende: 53.
Calhoun vein: geology: 467; mineralogy: 467; orebodies: 467; pitchblende in mineable quantities not known from this mine: 467; pitchblende produced from it from 1897–1914; no figures on amount: 467.
West Calhoun mine owned by Realty Co. of Denver: geology: 467; pitchblende production believed small since only available production figures show 240 lbs. with 37.5% U_3O_8 mined in 1912: 467.
Duponts' exploring small area: 420.
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German lode: pitchblende: 473.
German mine: pitchblende: 78, 82; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore; assays of uranium ores and concentrates given: 398; pitchblende with gold and silver ore: 460; pitchblende, production: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7;
German-Belcher mine: pitchblende: 53.
Iron operations: uranium: 53.
Kirk mine: pitchblende: 53, 78, 82, 473; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore; assays of uranium ore: 398; pitchblende veins found from surface through 400 ft. depth: 455; pitchblende with gold and silver ore: 460; pitchblende, production: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7,104.
Leavenworth mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460.
Mitchell mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore: 398, 460; structure and mineralization: 398.
Pewabic mine in Russell Gulch: pitchblende in vein deposits with gold and silver ore: 398, 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; structure and mineralization: 398; operations: 53.

Pyrenees mine: uraninite-bearing ore from dump; polished surface studied showing rather abundant uraninite: 506.
Russell Gulch: pitchblende, analysis: 68.
Springdale mine: uraninite-bearing ore from dump; polished surface studied showing rather abundant uraninite: 506.
Wood mine near head of Leavenworth Gulch: mineralization and structure: 398; mineralogy of deposit: 7; pitchblende: 53, 78, 82, 397, 473; pitchblende, analysis: 68; pitchblende in vein deposits with gold and silver ore; assays of uranium ore: 398; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460; pitchblende discovered in 1871: 455; uraninite: 7, 104; under lease to and operated by Realty Co. of Denver: dump samples show wide discrepancy between radioactivity and uranium content with three samples showing ranges of 1.03–0.002% e U, 0.055—0.002% eU, and 0.005–0.001% eU: 452; geology: 452; high radioactivity on dump and in uppermost workings: 452; pitchblende in vein deposits: 452; reconnaissance investigations in 1950: 452.
Wood vein:
assays of pitchblende samples ranged in uranium content from 0.23 to 14.5% eU and from .008 to 14.27% U: 467; geology: 467; history; pitchblende first discovered on dump there in 1871: 467; mineralogy: 467; orebodies: 467; production figures given for uranium ore produced from this mine; total about 102,600 t. ore with 30,040 lbs. U_3O_8: 467; suggestions for further exploration: 467.
Wyandotte mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460.
Uranium Production—
Front Range Mineral Belt—
Central City Mining District—
Quartz Hill: principal domestic source of pitchblende, a recorded 110,757 lbs. of U_3O_8 produced there: 394.
Belcher mine: pitchblende: 330.
Calhoun vein in East Calhoun mine: pitchblende produced in commercial quantities from gold- and silver-bearing vein (no figures available): 467.
West Calhoun mine: only available figures show 240 lbs. with 37.5% U_3O_8 mined in 1912: 467.
German mine: German Gold and Uranium Co. at Central City mined a few hundred lbs. of pitchblende; used for experimental work: 330.
German and Belcher mines: pitchblende with over 70% U_3O_8, 240 lbs. ore produced between 1911 and 1913, and also 1 ton with 2% U_3O_8: 460.
German-Belcher vein in German and Belcher mines: pitchblende produced in commercial quantities from gold- and silver-bearing vein: 467.
Kirk mine: pitchblende: 330.
Kirk vein: pitchblende mined in commercial quantities from gold- and silver-bearing vein: 467.
Wood and Kirk mines: average ore grade 0.2% U_3O_8: 394; producers of over 98% of U_3O_8 in area: 394.
Wood vein in Wood mine: pitchblende produced in commercial quantities from gold- and silver-bearing vein: 467; production figures for U ore from this mine total about 102,600 t. ore with 30,040 lbs. U_3O_8: 467.
Gummite Occurrences
See under individual county names and under Index III, Gummite Occurrences—Colorado: 234.
Gunnison County
Betafite Occurrences—
Brown Derby: with microlite in pegmatite: 70.
Microlite Occurrences—
*Bazooka spodumene prospect, owned by Leonard Nesbit of Parlin, head of Wood Gulch near Doyle: in pegmatite: 234.
Brown Derby: with betafite in pegmatite: 70.
**Brown Derby mine of Hayden Mining Co., 17 mi. E. of Gunnison, dikes on E. wall of Quartz Creek valley: in pegmatite with monazite; chemical analysis shows U but no Th: 234.
***Brown Derby No. 5 prospect of Hayden Mining Co., in small gulch on side of Brown Derby ridge: in pegmatite: 234.
****Opportunity No. 1 prospect E side of Quartz Creek near Doyle: in pegmatite: 234.
*****White Spar No. 1 prospect of the Colorado Feldspar Co., N side of Tollgate Gulch near Brown Derby mine: in pegmatite: 234.
Monazite Occurrences—
Brown Derby mine: in pegmatite with microlite: 234.
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: with samarskite, rare earth minerals, in pegmatite dike: 502.

*Hereafter cited as Bazooka spodumene prospect.
**Hereafter cited as Brown Derby mine.
***Hereafter cited as Brown Derby No. 5 prospect.
****Hereafter cited as Opportunity No. 1 prospect.
*****Hereafter cited as White Spar No. 1 prospect.

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Samarskite Occurrences—
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: with monazite, rare earth minerals, in pegmatite dike: 502.
Gold Creek near Gunnison: 535, 536.
Thorium Occurrences—
Bazooka spodumene prospect: pegmatite with microlite: 234.
Brown Derby: betafite, microlite in pegmatite: 70.
Brown Derby mine: pegmatite with microlite and monazite: chemical analysis of microlite, 1.69% UO_3, 2.40% UO_2, no Th.: 234.
Brown Derby No. 5 prospect: pegmatite with microlite: 234.
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: samarskite, monazite, rare earth minerals, in pegmatite dike: 502.
Gold Creek near Gunnison: samarskite: 535, 536.
Opportunity No. 1 prospect: pegmatite with microlite: 234.
White Spar No. 1 prospect: pegmatite with microlite: 234.
Uranium Occurrences—
Bazooka spodumene prospect: pegmatite with microlite: 234.
Brown Derby: betafite, microlite in pegmatite: 70.
Brown Derby mine: pegmatite with microlite and monazite; chemical analysis of microlite, 1.69% UO_3, 2.40% UO_2, no Th.: 234.
Brown Derby No. 5 prospect: pegmatite with microlite: 234.
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: samarskite, monazite, rare earth minerals in pegmatite dike: 502.
Gold Creek near Gunnison: samarskite: 535; samarskite, radioactive minerals: 536.
Opportunity No. 1 prospect: pegmatite with microlite: 234.
White Spar No. 1 prospect: pegmatite with microlite: 234.
Huerfano County
Carnotite Occurrences—
McIntire prospect, Huerfano Park: with carbonized wood and radioactive iron oxide as uranium-bearing materials in copper-uranium deposit in Triassic Shinarump conglomerate: 509.
Uranium Occurrences—
McIntire prospect, Huerfano Park: carnotite, carbonized wood, and radioactive iron oxide as uranium-bearing materials in copper-uranium deposit in Triassic Shinarump conglomerate: 509.
Jefferson County (Colorado Front Range)
Carnotite Occurrences—
Denver, 12 mi. from, in center of S. 28, R. 70 W., T. 2 S., Sixth Principal Meridian: in Laramie coal formation: 505.
Golden, N of: in lignites: 53.
Coal, Uranium-bearing—
Denver, 12 mi. from, in center of S. 28, R. 70 W., T. 2 S., Sixth Principal Meridian: carnotite in Laramie coal formation: 505.
Gadolinite Occurrences—
*Roscoe beryl prospect in wall of Clear Creek Canyon 8 mi. W of Golden: in pegmatite with monazite, previously reported but not found in 1943: 234.
Lignites, Uranium-bearing—
Golden, N of: carnotite: 53.
Limestones, Uranium-bearing—
Leyden coal mine: uranium minerals in limestone of Laramie formation of Cretaceous age: 509.
Monazite Occurrences—
**Bigger mica mine owned by D. N. Biggers of Littleton, on northern ridge of Bald Mountain at divide between South Turkey and Deer Creeks: in pegmatite with uraninite: 234.
***Centennial Cone beryl-monazite prospect on ranch owned by Frank Termantoni, 7 mi. W of Golden: in pegmatite: 234.
Roscoe beryl prospect: in pegmatite with gadolinite, previously reported but not found in 1943: 234.
Pitchblende Occurrences—
Ralston Creek: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Several mines (not named): 82.
Thorium Occurrences—
Bigger mica mine: pegmatite with monazite, uraninite: 234.
Centennial Cone beryl-monazite prospect: pegmatite with monazite: 234.
Roscoe beryl prospect: pegmatite with gadolinite and monazite previously reported but not found in 1943: 234.
Uraninite Occurrences—
Bigger mica mine: in pegmatite with monazite: 234.
Uranium Occurrences—
Bigger mica mine: pegmatite with monazite, uraninite: 234.
Denver, 12 mi. from, in center of S. 28, R. 70 W., T. 2 S., Sixth Principal Meridian: carnotite in Laramie coal formation; readily accessible for mining and shipping by railroad: 505.
Golden, N of: carnotite in lignites: 53.
Golden Gate Canyon: uranium: 53.
Leyden coal mine: uranium minerals in limestone of Laramie formation of Cretaceous age: 509.
Ralston Creek: massive and sooty pitchblende in veins of quartz-sulfide type: 455; uranium: 53.
Several mines (not named): pitchblende: 82.
Johannite Occurrences
See under individual county names and under Index III, Johannite Occurrences—Colorado: 493.
Kasolite Occurrences
See under individual county names and under

*Hereafter cited as Roscoe beryl prospect.
**Hereafter cited as Bigger mica mine.
***Hereafter cited as Centennial Cone beryl-monazite prospect.

Index III, Kasolite Occurrences—Colorado: 504.
Lake County
Pitchblende Occurrences—
Colorado Mineral Belt—
Leadville Mining District: 477.
St. Kevin Mining District: questionable occurrence, with torbernite: 477.
Torbernite Occurrences—
Colorado Mineral Belt—
St. Kevin Mining District: with questionable occurrence of pitchblende: 477.
Uranium Occurrences—
Colorado Mineral Belt—
Leadville Mining District: uranium as coatings on fracture surfaces or disseminations in country rock: 477.
St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also as coatings on fracture surfaces and disseminations in country rock: torbernite and sooty pitchblende present, probably alteration products of primary pitchblende: 477.
Land Withdrawals
See under individual county names and under Index III, Land Withdrawals-Colorado: 90, 555.
La Plata County (Colorado Plateau)
Carnotite Processes—
Qualified Uranium Mills—
Durango: V.C.A. mill to treat carnotite ore from Navajo Indian Reservation: 140.
Uranium Processes—
Qualified Uranium Mills—
Durango:
V.C.A. mill (owned by U.S.A.E.C.): 140, 144, 413, 431, 497, 538, 557.
V.C.A. mill to treat Navajo Indian Reservation carnotite ore: 140.
Mill formerly operated by U.S. Vanadium Co. for Metals Reserve Co., capacity 100 t. daily reported in 1946: 440.
Uranium Production—
Durango: V.C.A. mill: 538; capacity increased: 558.
Larimer County (Colorado Front Range)
Autunite Occurrences—
Crystal Mountain District—
Crystal Mt. District 18 mi. SW of Fort Collins: in Big Boulder pegmatite with uranium minerals: 234; in Double Opening pegmatite with uranium minerals: 234.
*Big Boulder prospect owned by Mountain States Mineral Production Co. and worked by United Beryllium Ores and Metals Corp., 2 mi. SE of Crystal Mountain: in Big Boulder pegmatite with gummite: 234.
**Double Opening prospect of United Beryllium Ores and Metals Corp., SW of Fort Collins: in Double Opening pegmatite with gummite, torbernite, uraninite: 234.

*Hereafter cited as Big Boulder prospect.
**Hereafter cited as Double Opening prospect.

*Hyatt beryl mine leased to United Beryllium Ores and Metals Corp., 1 mi. N. of North Fork Big Thompson River and 1½ mi. NNW of Drake: in pegmatite with torbernite, uraninite: 234.
Gummite Occurrences—
Crystal Mountain District—
Crystal Mt. District 18 mi. SW of Fort Collins: in Big Boulder pegmatite with uranium minerals: 234; in Double Opening pegmatite with uranium minerals: 234.
Big Boulder prospect: in Big Boulder pegmatite with autunite: 234.
Double Opening prospect: in Double Opening pegmatite with autunite, torbernite, uraninite: 234.
Pitchblende Occurrences—
Copper King mine, 45 mi. NW of Fort Collins: 53, 543.
Prairie Divide: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Thorium Occurrences—
Copper King mine, 45 mi. NW of Fort Collins: pitchblende: 543.
Torbernite Occurrences—
Crystal Mountain District—
Crystal Mt. District 18 mi. SW of Fort Collins: in Big Boulder pegmatite with uranium minerals: 234; in Double Opening pegmatite with uranium minerals: 234.
Double Opening prospect: in Double Opening pegmatite with autunite, gummite, uraninite: 234.
Hyatt beryl mine: pegmatite with autunite, uraninite: 234.
Uraninite Occurrences—
Crystal Mountain,District—
Double Opening prospect: in Double Opening pegmatite with autunite, gummite, torbernite: 234.
Hyatt: in beryl pegmatite: 70.
Hyatt beryl mine: in pegmatite with autunite, torbernite: 234.
Uranium Development—
Copper King mine, 45 mi. NW of Fort Collins: 77.
Uranium Occurrences—
Buckhorn mine, 17 mi. SW of Fort Collins: in pegmatite: 491.
Copper King mine, 45 mi. NW of Fort Collins: pitchblende: 53, 543.
Crystal Mountain District—
Crystal Mt. District 18 mi. SW of Fort Collins: Big Boulder pegmatite with uranium minerals: 234; Double Opening pegmatite with uranium minerals: 234.
Big Boulder prospect: Big Boulder pegmatite with autunite, gummite: 234.
Double Opening prospect: Double Opening pegmatite with autunite, gummite, torbernite, and uraninite: 234.
Hyatt: uraninite in beryl pegmatite: 70.
Hyatt beryl mine: pegmatite with autunite, torbernite, uraninite: 234.
Prairie Divide: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Treasure Hill area 20 mi. NW of Fort Col-

*Hereafter cited as Hyatt beryl mine.

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lins: 15 samples tested with Geiger counter showed a range of 0.0000–0.003% eU and an average of 0.001% eU: 508; geology: 508.
Casey lease, leased from Mrs. Ruth Casey: one sample from dump pit showed 1.0 tested with counter at scale 0.2 and 0.000% eU: 508; geology: 508.
Treasure Hill Nos. 1–6 claims owned by Mrs. Mildred Davis and Orville and Clifford Woodhams: ten samples showed a range of 1.0–2.0 tested with counter at scale 0.2 and 0.000–0.002% eU: 508; geology: 508.
West Point claim owned by Mrs. Mildred Davis and Orville and Clifford Woodhams: four samples showed a range of 0.5–2.5 tested with counter at scale 0.2 and 0.0000–0.003% eU: 508; geology: 508.
Lignites, Uranium-bearing
See under individual county names and under Index III, Lignites, Uranium-bearing—Colorado: 53.
Limestones, Uranium-bearing
See under individual county names and under Index III, Limestones, Uranium-bearing—Colorado: 509.
Mesa County (Colorado Plateau)
Carnotite Occurrences—
East Gateway area—
Calamity Group:
Calamity group, Calamity Mesa: drilling in U.S.G.S. drilling program yielding geologic logs for study and resulting formulation of geologic guides to carnotite deposits: 501.
Calamity Nos. 1 and 3 and Triangle claims: carnotite in fossil trees, irregular elongate rolls, and blanket bodies parallel to bedding of sediments of lower Morrison formation exposed on three sides, drilled by U.S.B.M. and showing from none or less than 0.05 to 1.81% U_3O_8: 440.
Calamity Nos. 7, 8, 9, and 23, and Crackerjack claims: carnotite in elongate rolls and fossil trees, drilled by U.S.B.M., and showing from less than 0.05 to 1.04% U_3O_8; and one blanket type deposit: 440.
Calamity Nos. 13, 17, and 18 claims: carnotite and uranium-vanadium minerals in fossil logs, which when close together are connected by blanket-like layers of ore, drilled by U.S.B.M., and showing from less than 0.05 to 1.70% U_3O_8: 440.
Calamity Nos. 20, 27, and 3, and Dixie claims: carnotite in fossil logs, small rolls, and two zones in some cases, drilled by U.S.B.M., and showing from less than 0.05 to 1.57% U_3O_8 with no ore revealed in Dixie claim by drilling: 440.
Calamity Mesa, Uravan Mineral belt: carnotite deposits in small patches of favorable ground: 417.
Maverick Group:
Hidden Treasure claim: carnotite in crescent-shaped ore deposit, drilled by U.S.B.M. showing from less than 0.05 to 0.11% U_3O_8 mined from two zones 15 ft. apart: 440.
Hummer and Great Hesper claims: carnotite in small rolls in elongate, crescent-shaped cluster drilled by U.S.B.M. and showing from less than 0.05 to 0.63% U_3O_8: 440.
Hummer mine worked by U.S. Vanadium Co.: carnotite; even fines collected: 456.
Outlaw Mesa area, Uravan Mineral belt: carnotite deposits in several patches of favorable ground from one to several thousand feet wide and over a mile long: 417.
Rio Dolores around Gateway area: in sandstone along river: 78, 82.
Carnotite Processes—
Climax Uranium Co. mill, Grand Junction: acid-leaching process mill: 533, 534.
Clays—
Mineralogical Studies—
Base-exchange determination: Calamity Mesa samples: 500.
Chemical analyses: Calamity Mesa samples: 500.
Differential thermal analysis: Calamity Mesa samples: 500.
Electron microscope study: Calamity Mesa samples: 500.
Petrographic microscope study: Calamity Mesa samples: 500.
X-ray powder patterns: Calamity Mesa samples: 500.
Mineralogical Studies—
Clays—
Base-exchange determination: Calamity Mesa samples: 500.
Chemical analyses: Calamity Mesa samples: 500.
Differential thermal analysis: Calamity Mesa samples: 500.
Electron microscope study: Calamity Mesa samples: 500.
Petrographic microscope study: Calamity Mesa samples: 500.
X-ray powder patterns: Calamity Mesa samples: 500.
Tyuyamunite Mineralogy—
Calamity Creek specimen: 438.
Tyuyamunite Occurrences—
Calamity Creek: 438.
Uranium Exploration—
Calamity group, Calamity Mesa: U.S.G.S. drilling program gave geologic logs: 501; study of logs led to formulation of geologic guides to carnotite deposits: 501; numerical evaluation of individual guides: 501.
Calamity Mesa: diamond drilling: 154.
Outlaw Mesa: diamond drilling: 154.
Uranium Mining—
Hummer mine worked by U.S. Vanadium Co.: equipment: 456; good example of advantages of clean mining; even fines of carnotite collected for recovery value: 456; mining methods: 456; uranium orebody mined from below: 456.
Outlaw Mesa, Climax Uranium Co. operations: equipment; similar equipment

operated by Minerals Engineering Co. at Temple Mountain, Utah: 456; good example of modern mechanized mining: 456; mining methods: 456; uranium ore in lenses: 456.
Uranium Occurrences—
Arrowhead group, Calamity area: Minerals Engineering Co. operating mine: 413.
Calamity Creek: tyuyamunite: 438; uranium mineral: 434.
East Gateway area—
Calamity Group:
Calamity group, Calamity Mesa: carnotite deposits, drilled in U.S.G.S. drilling program, yielding geologic log for study and resulting formulation of geologic guides: 501.
Calamity Nos. 1 and 3 and Triangle claims: carnotite in fossil trees, irregular elongate rolls, and blanket bodies parallel to bedding of sediments of lower Morrison formation exposed on three sides, drilled by U.S. B.M., and showing from none or less than 0.05 to 1.81% U_3O_8: 440.
Calamity Nos. 7, 8, 9, and 23, and Crackerjack claims: carnotite in elongate rolls and fossil trees, drilled by U.S.B.M., and showing from less than 0.05 to 1.04% U_3O_8; and one blanket type deposit: 440.
Calamity Nos. 13, 17, and 18 claims: carnotite and uranium-vanadium minerals in fossil logs, which when close together are connected by blanket-like layers of ore, drilled by U.S.B.M., and showing from less than 0.05 to 1.70% U_3O_8: 440.
Calamity Nos. 20, 27 and 3, and Dixie claims: carnotite in fossil logs, small rolls, and two zones in some cases, drilled by U.S.B.M., and showing from less than 0.05 to 1.57% U_3O_8 with no ore revealed in Dixie claim by drilling: 440.
Calamity Mesa, Uravan Mineral Belt: 411; analyses gave average uranium content of 0.0014% in gray clay and 0.0017% in red clay: 500; carnotite deposits in small patches of favorable ground: 417; mineralogical studies made on clays: 500; radiometric studies showed an average count of 0.0022% eU for gray clay and 0.0018% eU for red clay: 500; 21 samples of clays tested: 500; uranium in sandstone in Morrison formation underlain by red and gray clays at varying depths: 500.
Maverick Group:
Hidden Treasure claim: carnotite in crescent-shaped ore deposit, drilled by U.S.B.M., showing from less than 0.05 to 0.11% U_3O_8, mined from two zones 15 ft. apart: 440.
Hummer and Great Hesper claims: carnotite in small rolls in elongate, crescent-shaped cluster, drilled by U.S.B.M. and showing from less than 0.05 to 0.63% U_3O_8: 440.
Gateway: 411.
Hummer mine worked by U.S. Vanadium Co.: carnotite; even fines collected: 456.
Outlaw Mesa area, Uravan Mineral Belt: carnotite deposits in several patches of favorable ground from one to several thousand feet wide and over a mile long: 417.
Climax Uranium Co. operations: 456.
Rio Dolores around Gateway area: carnotite in sandstone along river: 78, 82.
Uranium Ore Guides—
Clays underlying Morrison formation: Calamity Mesa: 500.
Geologic Guides to Carnotite Deposits:
Calamity group, Calamity Mesa: altered mudstone associated with ore-bearing sandstone: 501; numerical evaluation of individual guides: 501; presence of abundant carbonaceous material in ore-bearing sandstone: 501; thickness and color of ore-bearing sandstone: 501.
Uranium Processes—
Climax Uranium Co. mill, Grand Junction: acid-leaching process for carnotite: 533; first mill to acid-leach carnotite: 534; mill operations: 73, 431, 497, 557.
Gateway: inactive uranium mill, formerly operated by Gateway Alloys under contract with Metals Reserve Co.; capacity 15 t. daily reported in 1946: 440.
Grand Junction: new uranium processing mill may be built by Vitro Manufacturing Co.: 513, 521.
Uranium Production—
Grand Junction: Climax Uranium Co. mill in operation: 73, 431, 497, 557; new uranium processing mill may be built by Vitro Manufacturing Co.: 513, 521.
Mesa-Montrose-San Miguel Counties (Colorado Plateau)
Carnotite Occurrences—
Uravan mineral belt: deposits in Morrison formation: 417; ore averages 0.25% U_3O_8 and 2% V_2O_5: 417; orebodies, irregular tabular layers, parallel to sandstone bedding, ranging in width from a few to several hundred feet, with an average thickness of 2–4 ft. and an ore content of a few to several thousand tons: 417; origin probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417.
Carnotite Production—
Uravan mineral belt: 565,000 t. carnotite ore produced from 1936–1943 or 78% of entire production from Colorado and Utah main producing region: 417.
Uranium Occurrences—
Uravan mineral belt: carnotite deposits in Morrison formation: 417; carnotite ore averages 0.25% U_3O_8 and 2% V_2O_5: 417; orebodies, irregular tabular layers, parallel to sandstone bedding, ranging in width from a few to several hundred feet, with an average thickness of 2–4 ft. and ore content of a few to several thousand tons: 417; origin probably from groundwater

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solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417.
Uranium Ore Guides—
Uravan mineral belt: geologic guides and their application: 417.
Uranium Production—
Uravan mineral belt: 565,000 t. carnotite ore produced from 1936–1943 or 78% of entire production from Colorado and Utah main producing region: 417.
Microlite Occurrences
See under individual county names and under Index III, Microlite Occurrences—Colorado: 70, 234.
Mineral County (partly Colorado Plateau)
Uranium Occurrences—
Blanco Basin to West Fork: uranium claims: 514.
Mineralogical Studies
See under individual county names and under Index III, Mineralogical Studies—Colorado: 500.
Moffat County (Colorado Plateau)
Carbonaceous Shales, Uranium-bearing—
Skull Creek: carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Carnotite Occurrences—
Blue Mountain: 34.
Blue Mountain near Skull Creek: 78, 82.
Blue Mountain, 2 mi. W. of Skull Creek: 422.
Blue Mountain Mining District: 241.
Skull Creek: 511; with volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Skull Creek Mining District: 241.
Uranium Occurrences—
Blue Mountain: carnotite: 34.
Blue Mountain near Skull Creek: carnotite: 78, 82.
Blue Mountain, 2 mi. W. of Skull Creek: carnotite: 422.
Blue Mountain Mining District: carnotite: 241.
Skull Creek: carnotite: 511; carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstones of Permian and Pennsylvanian Maroon formation: 509.
Skull Creek Mining District: carnotite: 241.
Monazite Occurrences
See under individual county names and under Index III, Thorium Occurrences—Colorado: 11, 78, 82, 234, 252, 403, 457, 502.
Monazite Production
See under individual county names and under Index III, Monazite Production—Colorado: 457, 537.
Montezuma County (Colorado Plateau)
Carnotite Occurrences—
General: 41, 470.
Uranium Occurrences—
General: carnotite: 41; carnotite carrying 3–4% uranium oxide: 470.
Montrose County (Colorado Plateau)
Carnotite Mineralogy—
Analyses of specimens: 473.
Carnotite Occurrences—
General: 41, 470, 471, 476; radium extraction: 476.
Bull Canyon: in Morrison formation: 415.
Club Camp at Naturita: 34; group of claims in Morrison formation: 415.
Club Mesa, Uravan mineral belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Cracker Jack claim, Calamity Gulch: 34; in large petrified logs in Morrison formation: 415.
Dolores Camp claims, N side of San Miguel River: 34; in two large petrified logs in Morrison formation: 415.
Gypsum Valley District—
Gyp, Gyp No. 1, and Aztec mines: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing 0.25% U_3O_8 only in Gyp mine, with Gyp No. 1 and Aztec mines blank: 440.
Raven and adjoining claims: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing from less than 0.05 to 3.44% U_3O_8: 440.
Roosevelt mine: carnotite in thin layers, land owned by V.C.A., drilled by U.S.B.M., and showing less than 0.005% U_3O_8 in one drill hole, other was blank: 440.
Hydraulic Mining District: 241.
La Sal Creek: 439; analysis of specimen: 472; in sandstone: 7, 82.
Yellow Boy claim: 473.
La Sal Creek 6 mi. from Cashin: 104.
La Sal Mining District: 241.
La Sal Valley: 459.
Mesa Creek: in Morrison formation: 415.
Naturita Mining District: 241.
Paradox Valley: 1, 7, 439, 459, 464.
Cripple Creek claim, Long Park: 34.
Hieroglyphic camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite ore-bodies: 407.
Jack Rabbit camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite ore-bodies: 407.
Jo Dandy camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; carnotite occurrences in McElmo formation worked under 140 ft. of cover in some cases: 407; mined earlier by General Vanadium Co. and declared exhausted: 407.
Jo Dandy claim: 434.
Julian camp between Long Park and San Miguel River: camp left idle after ex-

haustion of exposed carnotite orebodies: 407.
Long Park: camps of Radium Co. of Colorado and Radium Luminous Materials Corp.: 407; carnotite mining carried out in open cuts, tunnels, and inclines: 407; carnotite ore production about 5 t. per day: 407; total shipping production of about 4200 t. carnotite ore averaging 2% U_3O_8 in McElmo formation: 407; Uravan mineral belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Maggie C claim, Long Park: 34.
Monogram Camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata 407; in Morrison formation: 415; mining operations were carried on by hand: 407; three adits worked and several carnotite ore-bodies present: 407.
Outlaw camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Paradox Creek: in sandstone: 78, 82.
Saucer Basin camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Shamrock group including Shamrock and Old Salt Lick claims, owned by U.S. Vanadium Co.: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from less than 0.05 to 1.43% U_3O_8: 440.
Roc Creek: 439; in sandstone: 78, 82.
Copper Prince claim: 473.
Roc Creek Mining District: 241.
Sinbad Valley: 435, 439, 459.
Uravan: deposits in Morrison formation: 417.
Vixen Mining District: 241.
Carnotite Processes—
General: carnotite ore formerly processed in mills at Denver or in the East: 407.
Standard Chemical Co.: formerly operated 50-ton mill on lower San Miguel River for treating carnotite ore: 407.
Uravan: expansion at U.S. Vanadium Co. mill; process for treating high-lime ores described: 557.
Clays—
Mineralogical Studies—
Base-exchange determination: Bitter Creek samples: 500.
Chemical analyses: Bitter Creek samples: 500.
Differential thermal analysis: Bitter Creek samples: 500.
Electron microscope study: Bitter Creek samples: 500.
Petrographic microscope study: Bitter Creek samples: 500.
X-ray powder patterns: Bitter Creek samples: 500.
Geophysical Exploration (Airborne)—
Club Mesa: first low-altitude operation; done by Texas Co. in 1950: 494.
Long Park: first low-altitude operation; done by Texas Co. in 1950: 494.
Geophysical Exploration (Ground)—
Bull Canyon: geophysical exploration work including 43 resistivity depth measurements and 13 sets of Potential-Drop-Ratio measurements: 498; majority of measurements made at Area D and at Newton and Zebra claims: 498; tables and graphs of results of the two types of measurements: 498.
Land Withdrawals—
Public Land Order 779: land withdrawn for U.S.A.E.C. use in uranium exploration: 555.
Mineralogical Studies—
Clays—
Base-exchange determination: Bitter Creek samples: 500.
Chemical analyses: Bitter Creek samples: 500.
Differential thermal analysis: Bitter Creek samples: 500.
Electron microscope study: Bitter Creek samples: 500.
Petrographic microscope study: Bitter Creek samples: 500.
X-ray powder patterns: Bitter Creek samples: 500.
Pitchblende Occurrences—
Paradox Valley: 464.
Tyuyamunite Mineralogy—
Paradox Valley specimen: 438.
Tyuyamunite Occurrences—
Paradox Valley: 438.
Uraninite Occurrences—
Paradox Valley, E slope: 104.
Uranium Exploration—
Drilling—
Club Mesa: diamond drilling: 154.
Long Park: diamond drilling: 154.
Geophysical Exploration (Airborne)—
Club Mesa: first low-altitude operation; done by Texas Co. in 1950: 494.
Long Park: first low-altitude operation; done by Texas Co. in 1950: 494.
Geophysical Exploration (Ground)—
Bull Canyon: 498.
Land Withdrawals—
Public Land Order 779: land withdrawn for U.S.A.E.C. use: 555.
Uranium Occurrences—
General: carnotite: 41, 471, 476; carnotite carrying 3–4% uranium oxide: 470.
Bitter Creek Group:
Dynamite mine: analyses gave average uranium content of 0.0014% in gray clay and 0.0017% in red clay: 500; mineralogical studies made on clays: 500; radiometric studies showed an average count of 0.0022% eU for gray clay and 0.0018% eU for red clay: 500; uranium in sandstone in Morrison formation underlain by red and gray clays with an irregular boundary between them: 500.
Bull Canyon: carnotite in Morrison formation: 415; geology: 498; geophysical exploration: 498; three or more operating uranium mines: 498.
Club Camp at Naturita: carnotite: 34; group of claims, carnotite in Morrison formation: 415.

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Club Camp of the Standard Chemical Co. on W rim of San Miguel canyon 4 mi. above junction with Dolores River: carnotite deposits in McElmo formation: fully equipped camp: 407.
Club Mesa, Uravan mineral belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Cracker Jack claim, Calamity Gulch: carnotite: 34; carnotite in large petrified logs in Morrison formation: 415.
Dolores Camp claims, N side of San Miguel River: carnotite: 34; carnotite in two large petrified logs in Morrison formation: 415.
Dolores Camp: uranium minerals: 434.
Dolores Camp of Standard Chemical Co. on E. rim of San Miguel canyon at junction of Dolores and San Miguel Rivers: carnotite deposits in McElmo formation did yield about 3 t. ore per day: 407.
Gypsum Valley District—
Gyp, Gyp No. 1, and Aztec mines: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing 0.25% U_3O_8 only in Gyp mine, with Gyp No. 1 and Aztec mines blank: 440.
Raven and adjoining claims: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing from less than 0.05 to 3.44% U_3O_8: 440.
Roosevelt mine: carnotite in thin layers, land owned by V.C.A., drilled by U.S. B.M., and showing less than 0.005% U_3O_8 in one drill hole, other was blank: 440.
Hydraulic Mining District: carnotite: 241.
La Sal Creek: carnotite: 439; carnotite in sandstone: 78, 82; carnotite, specimen analyzed: 472.
Yellow Boy claim: carnotite: 473.
La Sal Creek 6 mi. from Cashin: carnotite: 104.
La Sal Mining District: carnotite: 241.
La Sal Valley: carnotite: 459.
Mesa Creek: carnotite in Morrison formation: 415.
Naturita Mining District: carnotite: 241.
Paradox Valley: carnotite: 1, 7, 439, 459, carnotite, pitchblende: 464; tyuyamunite: 438; uranium production: 118.
Paradox Valley, E slope: uraninite: 104.
Cripple Creek claim, Long Park: carnotite: 34.
Hieroglyphic camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Jack Rabbit camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Jo Dandy camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; carnotite occurrences in McElmo formation worked under 140 ft. of cover in some cases: 407; mined earlier by General Vanadium Co. and declared exhausted: 407.
Jo Dandy claim: carnotite: 434.
Julian camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Long Park: carnotite mining carried out in open cuts, tunnels, and inclines: 407; carnotite ore production about 5 t. per day: 407; total shipping production of about 4200 t. carnotite ore averaging 2% U_3O_8 in McElmo formation: 407; camps of Radium Co. of Colorado and Radium Luminous Materials Corp.: 407; Uravan mineral belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Maggie C claim, Long Park: carnotite: 34.
Monogram camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; carnotite in Morrison formation: 415; mining operations were carried on by hand: 407; three adits worked and several carnotite orebodies present: 407.
Outlaw camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Paradox Creek: carnotite in sandstone: 78, 82.
Saucer Basin camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Shamrock group including Shamrock and Old Salt Lick claims, owned by U.S. Vanadium Co.: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from less than 0.05 to 1.43% U_3O_8: 440.
Roc Creek: carnotite: 439; carnotite in sandstone: 78, 82; uranium minerals: 416.
Copper Prince claim: carnotite: 473.
Roc Creek Mining District: carnotite: 241.
Sinbad Valley: carnotite: 435, 439, 459.
Uravan: carnotite deposits in Morrison formation: 417.
Vixen Mining District: carnotite: 241.
Uranium Ore Guides—
Clays underlying Morrison formation: Dynamite mine: 500.
Uranium Processes—
General:
Carnotite ore formerly processed in mills at Denver or in the East: 407.
Standard Chemical Co.: formerly operated a 50-ton mill on lower San Miguel River for treating carnotite ore: 407.
Qualified Uranium Mills—
Naturita: V.C.A. uranium mill: 144, 413, 431, 497, 538, 557; capacity of 100 t. daily reported in 1946: 440.
Uravan: U.S. Vanadium Co. uranium mill: 144, 148, 413, 431, 497, 519; capacity of 240 t. daily reported in 1946: 440; expansion at mill for carnotite ores; process for treating high-lime ores described: 557.

Uranium Production—
Naturita: V.C.A. uranium mill: 144, 413, 431, 440, 497, 538, 557.
Paradox Valley: 118.
Uravan: U.S. Vanadium Co. uranium mill: 144, 148, 413, 431, 440, 497, 519, 557.
Origin of Carnotite Occurrences:
See under individual county names and under Index III, Origin—Carnotite Occurrences—Colorado: 13, 22, 415, 417, 431.
Origin of Uranium Occurrences
See under individual county names and under Index III, Origin—Uranium Occurrences—Colorado: 13, 22, 415, 417, 431, 449, 474, 475, 499.
Origin of Uranothorite Occurrences
See under individual county names and under Index III, Origin—Uranothorite Occurrences—Colorado: 474, 475.
Ouray County
Black Slate, Uranium-bearing—
Uncompahgre Canyon S of Ouray: 53.
Pitchblende Occurrences—
Colorado Mineral Belt—
Lower Uncompahgre Mining District: 477.
Red Mountain Mining District: 477.
Upper Uncompahgre Mining District: 477.
Uranium Occurrences—
Colorado Mineral Belt—
Lower Uncompahgre Mining District: uranium with base and precious-metal veins: 477.
Pitchblende deposits present, probably hypogene: 477.
Red Mountain Mining District: uranium with pyritic veins and copper-lead-silver volcanic breccia pipes: 477.
Red Mountain Mining District, San Juan area: uranium: 551.
Uncompahgre Canyon S of Ouray: uranium in black slate: 53.
Uncompahgre Canyon, San Juan area: uranium: 551.
Upper Uncompahgre Mining District: uranium as coatings on fracture surfaces or disseminations in country rock: 477.
Park County (Colorado Front Range)
Carbonaceous Shales, Uranium-bearing—
Garo: carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Garo: with volborthite, associated with uraniferous carbonaceous shale and carbonized plant fossils, in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Pitchblende Occurrences—
Colorado Mineral Belt—
Alma Mining District: 477.
Uranium Occurrences—
Colorado Mineral Belt—
Alma Mining District: uranium with base and precious-metal veins; pitchblende present: 477.
Fairplay area: carnotite in Upper Morrison formation: 53.
Garo: carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils, in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Hartsel, 8 mi. N of: uranium: 512.
See also under Fremont-Park Cos.: 403.
Pitchblende Occurrences
See under individual county names and under Index III, Pitchblende Occurrences—Colorado: 53, 68, 78, 82, 102, 330, 394, 397, 398, 399, 432, 452, 453, 455, 458, 460, 464, 467, 468, 472, 473, 477, 484, 487, 496, 504, 511, 517, 543.
Pitchblende Production
See under individual county names and under Index III, Pitchblende Production—Colorado: 432, 467.
Radioactive Areas
See under individual county names and under Index III, Radioactive Areas—Colorado: 45, 53.
Radioactive Galena Ores
See under individual county names and under Index III, Radioactive Galena Ores—Colorado: 45.
Radioactive Occurrences
See under individual county names and under Index III, Radioactive Occurrences—Colorado: 467, 487, 503.
Radium Occurrences
See under individual county names and under Index III, Uranium Occurrences—Colorado: 503.
Radium Production
See under individual county names and under Index III, Radium Production—Colorado: 7, 415.
Rio Blanco County (Colorado Plateau)
Carnotite Occurrences—
Coal Creek: 34, 422.
Coal Creek, 14 mi. NE of Meeker: 78, 82.
Caywood claims: 423.
Coal Creek Mining District: 241.
J. Mackay mine No. 2 specimens: concentration process results: 418; mineralogy: 418.
Meeker: 511; in Morrison formation: 509.
Uranium Occurrences—
Coal Creek: carnotite: 34, 422.
Coal Creek 14 mi. NE of Meeker: carnotite: 78, 82.
Caywood Claims: carnotite: 423.
Coal Creek anticline: uranium in isolated orebodies on large anticlines and domes: 481.
Coal Creek Mining District: carnotite: 241.
J. Mackay mine No. 2: carnotite: 418; carnotite concentration process results: 418; carnotite mineralogy: 418.
Meeker: carnotite: 511; carnotite in Morrison formation: 509.
Uranium Ore Guides—
Proximity to major tectonic structures: second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a

COLORADO (contd.)
few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks, as in Coal Creek anticline: 481.
Routt County
Carnotite Occurrences—
General: 82.
Monazite Occurrences—
Hahns Peak: 11.
Timber Lake: 11, 78, 82.
Thorium Occurrences—
Hahns Peak: monazite, trace: 11.
Timber Lake: monazite: 78, 82; monazite, 416 and 520 lbs. per ton: 11.
Uranium Occurrences—
General: carnotite: 82.
Samarskite Occurrences
See under individual county names and under Index III, Samarskite Occurrences—Colorado: 414, 502, 535, 536, 539.
San Miguel County (Colorado Plateau, all except Placerville area deposits)
Asphalts, Uranium-bearing—
Placerville: 34.
Carbonaceous Deposits, Uranium-bearing—
Black King No. 5 prospect near Placerville in S. 27, T. 44 N., R. 11 W., owned by Hugh D., H. B., and Guy E. Weatherly (formerly called Evans property): thucholite, uraninite of commercial grade: 469.
White Spar prospect, 2000 ft. E of Placerville post office in S. 35, T. 44 N., R. 11 W., owned by Boyd Robinson: thucholite, uraninite of commercial grade: 469.
Carnotite Occurrences—
General: 41.
Cedar Mining District: 241.
Disappointment Creek near Cedar: 78, 82.
Egnar-Slick Rock District—
Buckhorn and Cone claims: carnotite in rolls and a log, drilled by U.S.B.M., and showing from less than 0.05 to 1.74% U_3O_8: 440.
Hawk Nos. 1 and 2 and Frankie No. 1 claims: carnotite in rolls, drilled by U.S.B.M., and showing from none or less than 0.05 to 2.62% U_3O_8: 440.
Hogback and Marie claims in Bishop and Summit Canyons: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Radium No. 2 and adjoining claims: carnotite in large orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 7.55% U_3O_8: 440.
Radium No. 4 claim: produced 325 t. ore with 1.75% V_2O_5 but U.S.B.M. drilling gave blank holes; ore in rolls: 440.
Radium No. 6 claim: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 7.00% U_3O_8: 440.
Uncle Sam and Mucho Grande claims: carnotite in lenticular orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Charles T Group:
Fraction No. 1 and Summit claims: carnotite in sandstone, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 2.13% U_3O_8: 440.
Legin Group:
Frenchy, King, King No. 2, May, and Sam claims: carnotite in elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.92% U_3O_8: 440.
Lower Group:
Cougar, Last Chance, Little Mariel, and Rainbow claims: carnotite in large elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.80% U_3O_8: 440.
Gypsum Valley District—
Gypsum Valley: 416.
Gypsum Valley, Disappointment District: 439.
Jack Knife claim: carnotite in a roll, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Lost claim: carnotite in thin layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.25% U_3O_8: 440.
Main Street claim: carnotite in layers and small rolls, drilled by U.S.B.M., and showing less than 0.05% U_3O_8 in one hole and blanks in two others: 440.
Pay Day claim: carnotite in two blanket-like layers of ore, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Pitchfork claim: carnotite in layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.10% U_3O_8: 440.
Riverview claim: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.33% U_3O_8: 440.
McIntyre District: in Morrison formation: 415.
Placerville: 78, 82, 435, 439, 459; with roscoelite in Entrada formation: 509.
Snyderville Mining District: 241.
Pitchblende Occurrences—
General: in vein deposits: 455.
Thucholite Occurrences—
Black King prospect near Placerville: containing minute specks of uraninite: 449; mineralogical studies: 449.
Black King No. 5 prospect near Placerville in S. 27, T. 44 N., R. 11 W., owned by Hugh D., H.B., and Guy E. Weatherly (formerly called Evans property): with uraninite: 469.
Uraninite Occurrences—
Black King prospect near Placerville: as minute specks in thucholite: 449; mineralogical studies of specimens: 445.
Black King No. 5 prospect near Placerville in S. 27, T. 44 N., R. 11 W., owned by Hugh D., H.B., and Guy E. Weatherly (formerly called Evans property): with thucholite: 469.
Disappointment Creek, at joining with Dolores River, 80 mi. W of Dolores: 104.
Uranium Exploration—
Egnar-Slick Rock area: diamond drilling: 154.

Gypsum Valley: diamond drilling: 154.
Uranium Occurrences—
General: carnotite: 41; pitchblende in vein deposits: 455.
Asphalts, Uranium-bearing—
Placerville: 34.
Black King prospect near Placerville: geology: 449; mineralization including copper, iron, and lead minerals and some chromian mica: 449; mineralogical studies of uraninite specimens: 445; origin, probably precipitation from hydrothermal solution: 449; roscoelite-type uranium-vanadium deposits in Entrada sandstone: origin: 449; thucholite containing minute specks of uraninite along a fault and a fissure: 449.
Black King No. 5 prospect near Placerville in S. 27, T. 44 N., R. 11 W., owned by Hugh D., H.B., and Guy E. Weatherly (formerly called Evans property): chemical analyses: 469; geology: 469; mineralization: 469; radiometric analyses: 469; structure: 469; uraninite, thucholite ore of commercial grade: 469.
Cedar Mining District: carnotite: 241.
Disappointment Creek, at joining with Dolores River and 80 mi. W of Dolores: uraninite: 104.
Disappointment Creek near Cedar: carnotite: 78, 82.
Egnar-Slick Rock District—
Buckhorn and Cone claims: carnotite in rolls and a log, drilled by U.S.B.M., and showing from less than 0.05 to 1.74% U_3O_8: 440.
Hawk Nos. 1 and 2 and Frankie No. 1 claims: carnotite in rolls, drilled by U.S.B.M., and showing from none or less than 0.05 to 2.62% U_3O_8: 440.
Hogback and Marie claims in Bishop and Summit Canyons: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Radium-Sitton area W of Egnar: F. A. Sitton operation: 413.
Radium No. 2 and adjoining claims: carnotite in large orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 7.55% U_3O_8: 440.
Radium No. 4 claim: produced 325 t. ore with 1.75% V_2O_5 but U.S.B.M. drilling gave blank holes; ore in rolls: 440.
Radium No. 6 claim: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 7.00% U_3O_8: 440.
Slick Rock: geology: 431; history: 431; largest mine of group, Incline No. 1 mine, producing 300 t. uranium ore per month: 431; mechanized equipment used at Incline Nos. 3 and 4 mines: 431; mining methods: 431; mining problems: 431; production of 500 to 600 t., average grade uranium ore per month: 431; typical small uranium operation: 431.
Uncle Sam and Mucho Grande claims: carnotite in lenticular orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Charles T Group:
Fraction No. 1 and Summit claims: carnotite in sandstone, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 2.13% U_3O_8: 440.
Legin Group: Minerals Engineering Co. operations: 413.
Frenchy, King, King No. 2, May, and Sam claims: carnotite in elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.92% U_3O_8: 440.
Lower Group:
Cougar, Last Chance, Little Mariel, and Rainbow claims: carnotite in large elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.80% U_3O_8: 440.
Gypsum Valley District—
Gypsum Valley: carnotite: 416.
Gypsum Valley, Disappointment District: carnotite: 439.
Jack Knife claim: carnotite in a roll, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Lost claim: carnotite in thin layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.25% U_3O_8: 440.
Main Street claim: carnotite in layers and small rolls, drilled by U.S.B.M., and showing less than 0.05% U_3O_8 in one hole and blanks in two others: 440.
Pay Day claim: carnotite in two blanket-like layers of ore, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Pitchfork claim: carnotite in layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.10% U_3O_8: 440.
Riverview claim: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.33% U_3O_8: 440.
McIntyre District: carnotite in Morrison formation: 415.
Placerville: carnotite: 78, 82, 435, 439; carnotite, roscoelite: 459; carnotite, roscoelite in Entrada formation: 509; uranium with asphalt: 34.
Snyderville Mining District: carnotite: 241.
White Spar prospect, 2000 ft. E of Placerville post office, in S. 35, T. 44 N., R. 11 W., owned by Boyd Robinson: chemical analyses: 469; geology: 469; radiometric analyses: 469; thucholite, uraninite ore of commercial grade: 469.
Uranium Ore Guides—
Geobotanical Guides—
Slick Rock: general indicator plant, *Purshia tridentata*: 409; selenium-indicator plants: 409; sulphur-indicator plants: 409.
Uranium Processes—
Slick Rock: inactive uranium mill, formerly owned by North Continent Mines, Inc., capacity of 20 t. daily reported in 1946: 440.

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Uranium Production—
Slick Rock: production of 500 to 600 t. average grade uranium ore per month with Incline No. 1 mine producing 300 t.: 431.
Sediments, Radium-bearing
See under individual county names and under Index III, Sediments, Radium-bearing—Colorado: 503.
Southwest Part
Carnotite Production—
General: total production including 1919, approximately 29,000 t. carnotite ore with 1.9% U_3O_8 and 5.8% V_2O_5: 407.
Uranium Occurrences—
Dulaney property: produces 60% of U.S. uranium: 518.
Uranium Production—
General: total production including 1919, approximately 29,000 t. carnotite ore with 1.9% U_3O_8 and 5.8% V_2O_5: 407.
Dulaney property: produces 60% of U.S. uranium: 518.
Former producers; Radium Co. of Colorado, Radium Luminous Materials Corp., and Standard Chemical Co.: 407.
Thorite Occurrences
See under individual county names and under Index III, Thorite Occurrences—Colorado: 234.
Thorium Occurrences
See under individual county names and under Index III, Thorium Occurrences—Colorado: 11, 12, 25, 68, 70, 78, 82, 234, 252, 395, 403, 414, 457, 474, 475, 502, 535, 536, 539, 543.
Bibliography: 9.
Thorium Production
See under individual county names and under Index III, Thorium Production—Colorado: 537.
Thucholite Occurrences
See under individual county names and under Index III, Thucholite Occurrences—Colorado: 449, 469.
Torbernite Occurrences
See under individual county names and under Index III, Torbernite Occurrences—Colorado: 234, 454, 477, 504, 509.
Tyuyamunite Mineralogy
See under individual county names and under Index III, Tyuyamunite Mineralogy—Colorado: 438.
Tyuyamunite Occurrences
See under individual county names and under Index III, Tyuyamunite Occurrences—Colorado: 438.
Uraconite Occurrences
See under individual county names and under Index III, Uraconite Occurrences—Colorado: 493.
Uraninite Occurrences
See under individual county names and under Index III, Uraninite Occurrences—Colorado: 7, 70, 104, 234, 250, 445, 446, 449, 469, 504, 506, 507.
Uranium Development
See under individual county names and under Index III, Uranium Development—Colorado: 77.
Uranium Exploration
See under individual county names and under Index III, Uranium Exploration—Colorado: 18, 90, 124, 154, 409, 413, 452, 484, 494, 498, 501, 555.
Uranium Mining
See under individual county names and under Index III, Uranium Mining-Colorado: 456.
Uranium Occurrences
See under individual county names and under Index III, Uranium Occurrences—Colorado: 1, 7, 12, 13, 20, 22, 25, 34, 41, 46, 48, 53, 62, 63, 68, 70, 78, 82, 86, 95, 102, 104, 115, 118, 234, 241, 250, 330, 394, 395, 397, 398, 399, 400, 402, 403, 407, 411, 413, 414, 415, 416, 417, 418, 419, 420, 422, 423, 424, 426, 431, 432, 434, 435, 438, 439, 440, 443, 445, 446, 449, 452, 453, 454, 455, 457, 458, 459, 460, 464, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 481, 484, 486, 487, 491, 493, 496, 498, 499, 500, 501, 502, 504, 505, 506, 507, 508, 509, 511, 512, 514, 515, 516, 517, 518, 520, 535, 536, 539, 543, 551.
Bibliography: 9, 10, 424.
Uranium Ore Guides
See under individual county names and under Index III, Uranium Ore Guides—Colorado: 409, 417, 481, 500, 501.
Uranium Processes
See under individual county names and under Index III, Uranium Processes—Colorado: 53, 73, 140, 144, 148, 407, 413, 431, 440, 497, 513, 519, 521, 533, 534, 538, 557.
Uranium Production
See under individual county names and under Index III, Uranium Production—Colorado: 7, 73, 118, 144, 148, 330, 394, 407, 413, 415, 417, 431, 432, 459, 460, 467, 497, 511, 513, 518, 519, 521, 538, 557, 558.
Uranium Prospecting
See Uranium Exploration under individual county names and under Index III, Uranium Exploration—Colorado.
Uranium Purchases
See under individual county names and under Index III, Uranium Purchases—Colorado: 188.
Uranothorite Occurrences
See under individual county names and under Index III, Uranothorite Occurrences—Colorado: 403, 474, 475.
(For additional general information on Colorado and adjacent areas see COLORADO FRONT RANGE, COLORADO MINERAL BELT, and COLORADO PLATEAU)

COLORADO FRONT RANGE

(For specific localities see also under COLORADO—Boulder, Clear Creek, Gilpin, Jefferson, Larimer, and Park Cos.)
General
Pitchblende Occurrences—
General: 53, 496; age determinations: published age of 60 million years for Laramide pitchblende of Colorado Front Range confirmed by study: 492.
Uraninite Occurrences—
General: 53.
Uranium Occurrences—
General: 267: age determinations: published age of 60 million years for Laramide

pitchblende of Colorado Front Range, confirmed by study: 492; mineralogy of deposits: 496; pitchblende, uraninite: 53, 496. Reconnaissance work in 1949: 496.
Colorado
Pitchblende Occurrences—
General: in more than 20 vein deposits: 455.
Front Range Mineral Belt: distribution of deposits apparently restricted to an intermediate or transitional zone between central areas of pyritic gold veins and peripheral areas of silver-lead-zinc veins: 458; distribution related to pattern of hypogene zoning: 458; no indication as to whether pitchblende is more common in inner or outer part of intermediate zone: 458; significance of some geologic factors can be evaluated: 458; zonal distribution of pitchblende deposits influenced by at least seven geologic factors:
bostonite intrusives: 458; correlation of pitchblende with copper sulfides (and sulfosalts?): 458; differences between paragenetic sequence and position of minerals in successive zones: 458; effective depth of mineralization: 458; fault patterns: 458; multiple stages of uranium mineralization: 458; scale and complexity of zoning in plan and in section: 458.
Zonal Distribution:
Front Range Mineral Belt: 458.
Boulder County—
Grand Island Mining District—
Caribou mine: 53, 102; Geiger-Mueller survey: 484; geology: 484; in silver fissure veins in shear zones in quartz-monzonite stock 484; in veins of the quartz-sulfide carbonate type, with a little cobalt: 455; mineralization: 484; mineralogical examinations: 484; mineralogy: 484; ore zones vary from a few inches to 15 ft. in width and include silver, lead, zinc, and iron minerals with pitchblende: 484; results of Geiger-Mueller counter studies showed no radioactivity on the surface despite presence of pitchblende at the 1040 ft. level and its corresponding radioactivity: 484.
Gilpin County—
Wood and Kirk mines, Quartz Hill: ore with average grade of 0.2% U_3O_8: 394.
Uraninite Occurrences—
Boulder County—
Grand Island Mining District—
Radium vein, Caribou mine: occurs at 920 and 1040 ft. levels: 507.
Uranium Exploration—
Boulder County—
Grand Island Mining District—
Caribou mine: Geiger-Mueller counter survey of surface and underground workings showing no radioactivity at surface despite presence of pitchblende at 1040 ft. level: 484.
Uranium Occurrences—
General: pitchblende in more than 20 vein deposits: 455.
Front Range Mineral Belt:
pitchblende deposits with hypogene zonal distribution: 458.
Boulder County—
Grand Island Mining District—
Caribou mine: Geiger-Mueller survey: 484; geology: 484; mineralization: 484; mineralogical examinations: 484; mineralogy: 484; ore zones vary from a few inches to 15 ft. in width and include silver, lead, zinc, and iron minerals with pitchblende: 484; pitchblende: 53, 102; pitchblende in silver fissure veins in shear zones in quartz-monzonite stock: 484; pitchblende in veins of the quartz-sulfide-carbonate type, with a little cobalt: 455; results of Geiger-Mueller counter studies showed no radioactivity on the surface despite presence of pitchblende at the 1040 ft. level and its corresponding radioactivity: 484.
Radium vein: colloform banding in ore: 507; Geiger counter survey of dumps and underground workings showed presence of uraninite: 507; paragenesis of vein filling; mineralization in two stages, with uraninite deposited in the later stage: 507.
Gilpin County—
Wood and Kirk mines, Quartz Hill: pitchblende ore with average grade of 0.2% U_3O_8: 394.
Uranium Production—
Gilpin County—
Quartz Hill: principal domestic source of pitchblende in area, a recorded 110,757 lbs. of U_3O_8 produced there with average ore grade of 0.2% U_3O_8: 394.
Wood and Kirk mines: producers of over 98% of U_3O_8 in area: 394.
Pitchblende Occurrences
See above under General and Colorado—individual county names and under Index III, Pitchblende Occurrences—Colorado Front Range: 53, 102, 394, 455, 458, 484, 492, 496.
Uraninite Occurrences
See above under General and Colorado—individual county names and under Index III, Uraninite Occurrences—Colorado Front Range: 53, 507.
Uranium Exploration
See above under General and Colorado—individual county names and under Index III, Uranium Exploration—Colorado Front Range: 484.
Uranium Occurrences
See above under General and Colorado—individual county names and under Index III, Uranium Occurrences—Colorado Front Range: 53, 102, 267, 394, 455, 458, 484, 492, 496, 507.
Uranium Production
See above under General and Colorado—individual county names and under Index III, Uranium Production—Colorado Front Range: 394.

COLORADO MINERAL BELT (Southwestern Colorado)

Central Part
Pitchblende Occurrences—
Alma Mining District: 477.
Leadville Mining District: 477.
St. Kevin Mining District: questionable occurrence, torbernite: 477.
Torbernite Occurrences—
St. Kevin Mining District: with questionable occurrence of pitchblende: 477.
Uranium Occurrences—
Alma Mining District: uranium associated with base and precious-metal veins; pitchblende present: 477.
Leadville Mining District: uranium as coatings on fracture surfaces or disseminated in country rock; pitchblende present: 477.
St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also as coatings on fracture surfaces and disseminations in country rock: torbernite and sooty pitchblende (?) present, probably alteration products of primary pitchblende: 477.
Southwest Part
Pitchblende Occurrences—
Lower Uncompahgre Mining District: 477.
Red Mountain Mining District: 477.
Upper Uncompahgre Mining District: 477.
Uranium Occurrences—
Lower Uncompahgre Mining District: uranium associated with base and precious-metal veins; pitchblende present: 477; zonal relationship since uranium is close to boundary between pyrite-gold-base metal core and outer silver-lead-zinc zone: 477.
Red Mountain Mining District: uranium associated with pyritic veins and volcanic copper-lead-silver breccia pipes; pitchblende present: 477.
Upper Uncompahgre Mining District: uranium as coatings on fracture surfaces or disseminations in country rock; pitchblende present: 477.
Pitchblende Occurrences
See above and under Index III, Pitchblende Occurrences—Colorado Mineral Belt: 477.
Torbernite Occurrences
See above and under Index III, Torbernite Occurrences—Colorado Mineral Belt: 477.
Uranium Occurrences
See above and under Index III, Uranium Occurrences—Colorado Mineral Belt: 477.

COLORADO PLATEAU

(For specific localities see also under COLORADO—Archuleta, Dolores, Garfield, La Plata, Mesa, Mineral, Moffat, Montezuma, Montrose, Rio Blanco, and San Miguel Cos.; and under UTAH—Carbon, Daggett, Emery, Garfield, Grand, Kane, San Juan, Uintah, and Wayne Cos.)
General
Biogeochemical research: 409.
Carnotite Occurrences—
General: 20, 405, 444.
Accessibility: 440.
Colorado: carnotite field in southwest part of state: 407; small, widely scattered deposits: 457; deposits in Morrison formation stratigraphically controlled: 443.
Deposits in Arizona, Colorado, New Mexico and Utah: 441; spotty, scattered, average 0.25% U_3O_8, and occur in Salt Wash member of the Morrison formation, Shinarump conglomerate, and Entrada sandstone: 501.
Deposits in Colorado, New Mexico, and Utah: 407.
Deposits in Morrison formation: 440.
Deposits in Salt Wash member of Morrison formation, scattered erratically over Arizona, Colorado, New Mexico, and Utah: 431.
Description of ore deposits: 440.
Entrada formation: 63; sandstone: 22.
Exploration by U.S.B.M.: 440.
Geology: 407, 431, 440.
Government operations: 431.
Historical development of mining program: 431.
History: 440.
Mining development work: 440.
Mining methods and operations: 431.
Morrison formation: 22; channel deposits: 22; geology: 22; ore deposits: 22; origin: 22; stratigraphically controlled deposits in Salt Wash sandstone member: 509; uranium production: 22.
Origin: 13, 22, 407, 431; deposition by solution: 444.
Physiography: 440.
Property and ownership: 440.
Salt Wash formation: 63.
Sampling and metallurgy work on drill cores: 440.
Shinarump conglomerate: 22.
U.S.G.S. drilling program produced geologic logs of which study led to formulation of geologic guides to carnotite deposits: 501.
U.S.A.E.C's buying schedule and policies for carnotite ore: 441.
Uranium mills: 407, 440.
Utah: carnotite in eastern parts: 407; small, widely scattered deposits: 457.
Work of small scale operators: 431.
Carnotite Processes—
Carnotite ore formerly processed in mills at Denver or in the East: 407.
Colorado: Standard Chemical Co. formerly operated 50-ton mill on Lower San Miguel River for treating carnotite ore: 407.
Carnotite Production—
General: 1949 production from 250 operations, of which 80% were in Colorado: 457.
Geobotanical research: 409.
Geochemical research: 409.
Geophysical Exploration (Airborne)—
Instrumentation: 494.
Operational techniques: 494.
Results of operation: rim flying best in Colorado Plateau: 494.
Specific Operations:
Arizona, Colorado, New Mexico, and Utah: 494.
Airborne surveys for Hines Uranium Co.; no details available: 494.
Anaconda Mining Co. cooperating with

Rigg Aviation Service in Red Canyon district, Utah, 1951: 494.
Excalibur Uranium Corp. in Green River desert, near Moab, and Cataract Canyon, Utah, in 1951: 494.
First low-altitude operations, Texas Co. flights over Blanding, Utah, and Long Park and Club Mesa, Colorado, in 1950: 494.
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481; if mudstone pebbles are bleached, ore may or may not be present, so this is an unreliable guide to ore: 481.
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Radium Co. of Colorado: formerly produced 10% of carnotite ore: 407.
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Starlight Claims NE side of Mt. Hillers: tyuyamunite: 434.
Trachyte Creek: carnotite: 78; carnotite, tyuyamunite: 82.
Trachyte District: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406; mineralization localized along flanks of stream channelways: 406; ore grade of seven channel samples, mainly from underground workings, gave weighted averages of 0.245% U_3O_8 (chem.) and 1.307% V_2O_5: 406; orebodies include mineralized logs and carbonaceous material with ore also in surrounding sandstone: 406; ore exposures limited to rims surrounding topographic highs like Farmers Knob, John Hill, and West Knob: 406; part of property worked by Darys Ekker under oral lease from V.C.A.: 406; V.C.A. doing some mining, including exploratory wagon-drilling: 406.
Blitz Nos. 1–7 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Farmers Knob: uranium ore exposures limited to rims surrounding topographic high: 406.
Group of mines 2 mi. E of pass between Mt. Hillers and Mt. Holmes: uranium ore of good grade, not worked: 482.
John Hill: uranium ore exposures limited to rims surrounding topographic high: 406.
June Bell Nos. 1–4 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Minnie Pearl Nos. 1 and 2 claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Straight Creek claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Trachyte Nos. 1–20 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
V.C.A. claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
V.C.A. orebody on Farmers Knob operated by Darys Ekker: high-grade uranium ore: 482.
West Knob: uranium ore exposures limited to rims surrounding topographic high: 406.
Oak Creek prospect 17 mi. NE of Boulder: pitchblende, etc.: 21; radioactive asphaltite pellets: 509; torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Poison Springs, at confluence of Green and Colorado Rivers: uranium claims bought by V.C.A.: 540.
Spotted Dog claim: torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Uranium Ore Guides—
Geologic Guides—
Presence of limonite or brown rust stains: Henry Mts.: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around the mountain groups at distances proportional to the mass of the mountains, as in Henry Mts.: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed except for a few dikes and volcanic plugs, and ore occurs as isolated bodies at irregular intervals from crest of structure outward to base of its flanks, as in Waterpocket fold: 481.
Uranium Production—
Henry Mountains: from scattered claims: 482.
Geophysical Exploration (Airborne)
See under individual county names and under Index III, Geophysical Exploration (Airborne)—Utah: 494.
Grand County (Colorado Plateau)
Carnotite Occurrences—
General: 471.
Corvusite Nos. 1, 2, and 3 claims: on E slope of La Sal Mts.: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 1.12% U_3O_8: 440.
La Sal Mts. near Moab: 33; W slope: 104.
Mill Creek on Colorado (formerly Grand) River N of Moab: 404.

UTAH (contd.)
Moab: 470, 511.
Pack Creek, La Sal Mts.: 78; with tyuyamunite: 82.
Polar Mesa
Elva M. and adjoining claims: carnotite in saucer-shaped orebody, drilled by U.S.B.M., and showing from 0.05 to 0.24% U_3O_8 in the Elva M., Elva M. No. 2, and Mary No. 2 claims: 440.
Elva M. and Imp claims: 410.
Polar Nos. 2 and 3 claims: carnotite in irregular, well-defined rolls, drilled by U.S.B.M., and showing from 0.05 to 0.10% U_3O_8: 440.
Rim Rock and Rim Rock No. 2 claims: carnotite in large, thick, low grade orebody, drilled by U.S.B.M., and showing from less than 0.05 to 0.20% U_3O_8: 440.
Radium extraction: 476.
Richardson: 41, 78, 404, 410, 416, 464, 476, 511; with tyuyamunite: 82; on Colorado River: 34.
Thompsons area: 82, 511; 22 mi. SE of: 78.
Flat Top No. 1 claim: carnotite in rolls, drilling by U.S.B.M., and showing from 0.05 to 0.67% U_3O_8: 440.
Red Vanadium group: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.26% U_3O_8: 440.
Thompsons Springs, 10 mi. S of: 404.
Uvanco or Yellow Jacket mine: 410.
Geophysical Exploration (Airborne)—
Green River desert near Moab: airborne survey by Excalibur Uranium Corp. in 1951: 494.
Land Withdrawals—
Public Land order 745: 66 sq. mi. withdrawn for U.S.A.E.C. use: 542.
Pitchblende Occurrences—
Seven Mile Canyon: deposits replacing wood and rimming quartz and limestone pebbles: 485.
Tyuyamunite Occurrences—
Pack Creek, La Sal Mts.: with carnotite: 82.
Richardson: 434; with carnotite: 82.
Uranium Exploration—
Drilling—
Polar Mesa: diamond drilling: 154.
Thompsons area: diamond drilling: 154.
Geophysical Exploration (Airborne)—
Green River desert near Moab: airborne survey by Excalibur Uranium Corp. in 1951: 494.
Land Withdrawals:
Public Land Order 745: 66 sq. mi. for U.S.A.E.C. use: 542.
Uranium Occurrences—
General: Carnotite: 471.
Cane Creek anticline: uranium: 481.
Corvusite Nos. 1, 2, and 3 claims on E slope of La Sal Mts.: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 1.12% U_3O_8: 440.
La Sal Mts.: uranium; bleached sandstone surrounding ore-bodies: 481; near Moab: carnotite: 33; W slope: carnotite: 104.
Mill Creek on Colorado (formerly Grand) River N of Moab: carnotite: 404.
Moab: carnotite: 511; carnotite carrying 3–4% uranium oxide: 470.
Pack Creek, La Sal Mts.: carnotite: 78; carnotite, tyuyamunite: 82.
Polar Mesa: 411.
Elva M. and adjoining claims: carnotite in saucer-shaped orebody, drilled by U.S.B.M., and showing from 0.05 to 0.24% U_3O_8 in the Elva M., Elva M. No. 2, and Mary No. 2 claims: 440.
Elva M. and Imp claims: carnotite: 410.
Polar Nos. 2 and 3 claims: carnotite in irregular, well-defined rolls, drilled by U.S.B.M., and showing from 0.05 to 0.10% U_3O_8: 440.
Rim Rock and Rim Rock No. 2 claims: carnotite in large, thick, low grade orebody, drilled by U.S.B.M., and showing from less than 0.05 to 0.20% U_3O_8: 440.
Richardson: carnotite: 41, 78, 404, 410, 464, 476, 511; carnotite, tyuyamunite: 82; carnotite, etc.: 416; tyuyamunite, etc.: 434; on Colorado River: carnotite: 34.
Seven Mile Canyon: pitchblende, replacing wood and rimming quartz and limestone pebbles: 485; uranium in Shinarump formation and at base of Chinle formation: 481.
Thompsons area—
Thompsons: carnotite: 82, 511; 22 mi. SE of: carnotite: 78.
Thompsons district, 15 mi. SE of Thompsons: biogeochemical studies of deposits through study of distribution of selenium-indicator plants of *Astragalus* group: plant distribution controlled by selenium which is associated with uranium orebodies: 409; carnotite deposits in Morrison formation: 409.
Cactus Rat group, Thompsons: Minerals Engineering Co. operations: 413.
Flat Top No. 1 claim: carnotite in rolls, drilled by U.S.B.M., and showing from 0.05–0.67% U_3O_8: 440.
Red Vanadium group: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.26% U_3O_8: 440.
Thompsons Springs, 10 mi. S of: carnotite 404.
Uvanco or Yellow Jacket mine: carnotite: 410.
Yellow Cat District—
Eli Malich's Lucky Day claim: eligible for U.S.A.E.C. Bonus: 544; uranium oxide, production: 544.
L.A. Sutherland's Socko claim: eligible for U.S.A.E.C. Bonus: 544; uranium oxide, production: 544.
Uranium Ore Guides—
Geobotanical Guides—
Dakota sandstone, Harley Dome: analyses of plants growing on non-mineralized rocks and soils and showing uranium content in ppm. along with vanadium, selenium, molybdenum, and lead content: 409.
Mancos shale E of Thompsons: analyses of plants growing on non-mineralized rocks and soils and showing uranium content in ppm. along with vanadium, selenium, molybdenum, and lead content: 409.
McCoy-Flattop area: analyses of plants

growing on uranium-bearing rocks and soils and showing uranium content in ppm. along with vanadium, selenium, molybdenum, and lead content: 409.
Thompsons: general-indicator plants: 409; selenium-indicator plants: 409; sulfur-indicator plants: 409; special studies of distribution of selenium-indicator plants and the distribution patterns of various species: 409.
Yellow Cat area: analyses of plants growing on uranium-bearing rocks and soils and on nonmineralized rocks and soils and showing uranium content in ppm. along with vanadium, selenium, molybdenum, and lead content: 409.
Geologic Guides—
Bleaching of sandstone: La Sal Mts.: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around the mountain groups at distances proportional to the mass of the mountains, as in La Sal Mts.: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated bodies at irregular intervals from crest of structure outward to base of its flanks, as in Cane Creek anticline: 481.
Uranium Processes—
Thompsons: uranium ore sampling plant owned by and operated by U.S. Vanadium Co.: 413, 497, 519.
Uranium Production—
La Sal Mts. near Moab: carnotite: 33.
Thompsons: uranium ore sampling plant owned by and operated by U.S. Vanadium Co.: 413, 497, 519.
Gummite Occurrences
See under individual county names and under Index III, Gummite Occurrences—Utah: 480.
Johannite Occurrences
See under individual county names and under Index III, Johannite Occurrences—Utah: 401, 493.
Juab County
Carnotite Occurrences—
Thomas Range: in fluorite deposits in vein structures: 493; in uraniferous fluorite pipes: 504.
Fluorite, Uranium-bearing—
Honeycomb Hills: uranium minerals as coatings on fluorite in fluorite-quartz-sulfide deposits: 504.
Thomas Range: uraniferous fluorite pipes with carnotite: 504.
Bell Hill group of claims owned by Donald, Delbert, and T.E. Searle and Harold Ruthiford and leased to G.P. Spor: fluorite sample contained 0.4% uranium: 488.
Fluorine Queen property: irregular uraniferous fluorite pipe with carnotite: 504.
Fluorite (Original Spor) Group owned by G. P. Spor: less radioactive than Bell Hill and Harrisite groups but composite chip sample assayed 0.016% eU: 488.
Harrisite claims owned by E. D. and E. T. Harris: fluorite sample contained 0.25% uranium: 488.
Thursday property: uraniferous fluorite veins: 504.
Uranium Occurrences—
Fish Springs Mining District—
Honeycomb Hills: claims owned jointly by H. P. Bertelsen, Don and Stewart Sheldon, J. W. McAfee, and Owen Bauer: 489; geology: 489; mineralogy: 489; size and grade of deposits: 489; some radioactive fluorite: 489; uranium deposits in tuffs: 489; uranium minerals as coatings on fluorite in fluorite-quartz-sulfide deposits: 504; uranium-bearing minerals first discovered in tuffs in 1950 by H. P. Bertelsen: 489; uranospinite: 493.
Spider No. 1 claim about 15 mi. W of SW end of Fish Springs Mts.: ore sample with 0.17% U: 489; samples with 0.009–0.053% eU: 489; three samples from Pit No. 3 with 0.02, 0.07, and 0.19% U: 489; uranium-bearing minerals (possibly autunite, uranophane) in tuffs: 489.
Indian Creek: autunite in fluorite-quartz-sulfide deposits: 504.
Thomas Range: carnotite in fluorite deposits in vein structures: 493; uraniferous fluorite pipes with carnotite: 504.
Bell Hill group of claims owned by Donald, Delbert, and T. E. Searle and Harold Ruthiford and leased to G. P. Spor: uranium in fluorite; sample contained 0.4% uranium: 488.
Fluorine Queen property: irregular uraniferous fluorite pipe with carnotite: 504.
Fluorite (Original Spor) Group owned by G. P. Spor: uranium in fluorite; composite chip sample assayed 0.016% eU: 488.
Harrisite claims owned by E. D. and E. T. Harris: uranium in fluorite; sample contained 0.25% uranium: 488.
Thursday property: uraniferous fluorite veins: 504.
Tintic Mining District—
Centenial Eureka mine: zeunerite: 82, 421.
Uranospinite Occurrences—
Fish Springs Mining District—
Honeycomb Hills: 493.
Zeunerite Occurrences—
Tintic Mining District—
Centennial Eureka mine: 82, 421.
Kane County (partly in Colorado Plateau)
Autunite Occurrences—
Bulloch claims near Orderville: with carnotite, torbernite, and uraniferous carbonized wood disseminated or coating pebbles or fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
Pahreah, 9 mi. S of: with uranospinite: 78, 82.
Carnotite Occurrences—
Bulloch claims near Orderville: autunite, torbernite, and uraniferous carbonized wood, disseminated or coating pebbles or fracture surfaces in sandstones of the

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Cretaceous Dakota or Jurassic Summerville formations: 509.
Pahreah: 511.
Torbernite Occurrences—
Bulloch claims near Orderville: with autunite, carnotite, and uraniferous carbonized wood, disseminated or coating pebbles or fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
Virgin River: 82.
Uranium Occurrences—
Bulloch claims near Orderville: autunite, carnotite, torbernite, and uraniferous carbonized wood, disseminated or coating pebbles and fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
Pahreah: carnotite: 511; 9 mi. S of: autunite, uranospinite: 78, 82.
Paria Road claims Nos. 1–6, E of Kanab: uranium: 21.
Virgin River: torbernite: 82.
Uranospinite Occurrences—
Pahreah, 9 mi. S of: with autunite: 78, 82.
Land Withdrawals
See under individual county names and under Index III, Land Withdrawals-Utah: 90, 542.
Limestones, Uranium-bearing
See under individual county names and under Index III, Limestones, Uranium-bearing—Utah: 27, 426.
Meta-torbernite Occurrences
See under individual county names and under Index III, Meta-torbernite Occurrences—Utah: 493, 495, 510.
Monazite Occurrences
See under individual county names and under Index III, Thorium Occurrences—Utah: 11, 78, 82, 217.
Opal, Uranium-bearing
See under individual county names and under Index III, Opal, Uranium-bearing—Utah: 451.
Origin of Carnotite Occurrences
See under individual county names and under Index III, Origin—Carnotite Occurrences—Utah: 13, 22, 415, 431, 480.
Origin of Copper-Uranium Deposits
See under individual county names and under Index III, Origin—Copper-Uranium Deposits—Utah: 401, 412.
Origin of Uranium Occurrences
See under individual county names and under Index III, Origin—Uranium Occurrences—Utah: 13, 22, 401, 412, 415, 431, 451, 480, 499.
Phosphates, Uranium-bearing
See under individual county names and under Index III, Phosphates, Uranium-bearing—Utah: 306.
Phosphuranylite Occurrences
See under individual county names and under Index III, Phosphuranylite Occurrences—Utah: 401.
Pitchblende Occurrences
See under individual county names and under Index III, Pitchblende Occurrences—Utah: 21, 102, 401, 412, 429, 443, 455, 479, 485, 493, 495, 509, 532.

Piute County
Autunite Occurrences—
Marysvale area: 267, 429, 522, 526, 547; at various mines in district sometimes associated with torbernite and schroeckingerite: 451; in veins with other secondary uranium minerals and pitchblende: 493; with torbernite and uraninite: 441.
Buddy claim, Bertelson's deposit: 479.
Buddy mine: with a little pitchblende: 495.
*Bullion Monarch mine on Farmer John group of claims: 451; with pitchblende, meta-torbernite, schroeckingerite, torbernite, uranophane: 495.
Bullion Monarch Mining Co.: operations; indicated reserves of 500,000 t. with U_3O_8 content ranging from 0.7–0.26% on total tonnage; ore easily milled and reduced: 526; properties: 532, 552.
East Slope No. 2 deposit: with meta-torbernite, schroeckingerite, uranophane along face of open-cut coating fractures and joints in hornfels: 493.
Farmer John open pit, Bullion-Monarch Mining Co.: with pitchblende: 479.
Freedom lease, V.C.A.: with pitchblende: 479.
Freedom No. 1 (Seegmiller) mine: with trace of pitchblende, schroeckingerite, torbernite: 495.
**Freedom No. 2 mine on W slope of Pratt's Ridge under lease by V.C.A.: 451; with schroeckingerite, torbernite, uranophane: 495.
Papsy's Hope prospect owned by J. P. Fullmer: on fracture surfaces in altered feldspar porphyry, a part of the Bullion Canyon volcanics, with samples containing from 0.013–0.030% eU: 442; overlain by uranophane-bearing zone: 451.
Prospector lease, V.C.A.: with pitchblende: 479.
Prospector mine under lease by V.C.A.: near surface: 451; with pitchblende, torbernite, uranophane, a calcium-uranium-oxide mineral (analogue of fluorite): 495.
V.C.A. claims: 523; properties: 532.
Yellow Canary prospect: with uranophane (?): 495.
Fluorite, Uranium-bearing—
Marysvale area—
Farmer John claims: uranium mineralization with fluorite; leased by Bullion Monarch Mining Co. for fluorite mining and, later, for uranium development: 522.
Meta-torbernite Occurrences—
Marysvale area—
Bullion Monarch mine: with autunite, pitchblende, schroeckingerite, torbernite, uranophane: 495.
East Slope No. 2 deposit: with autunite, schroeckingerite, uranophane along face of open-cut coating fractures and joints in hornfels: 493.

* Hereafter cited as Bullion Monarch mine.
** Hereafter cited as Freedom No. 2 mine.

Opal, Uranium-bearing—
Marysvale area—
J. and L. alunite mine: in adit; material similar to opal but unusual green fluorescence like that of some hyalite: 451.
Trinity mine: in old workings: has brilliant green fluorescence: 451.
Pitchblende Occurrences—
Marysvale area: 102; in structurally controlled veins: 443; in veins of the fluorite-sulfide-quartz type: 455; in veins with secondary uranium minerals: 493; several deposits: 429.
Buddy mine: a little with autunite: 495.
Bullion Monarch mine: with autunite, meta-torbernite, schroeckingerite, torbernite, uranophane: 495.
Farmer John open pit, Bullion Monarch Mining Co.: with autunite: 479.
Freedom lease, V.C.A.: with autunite: 479.
Freedom No. 1 (Seegmiller) mine: trace with autunite, schroeckingerite, torbernite: 495.
Prospector lease, V.C.A.: with autunite: 479.
Prospector mine under lease by V.C.A.: with autunite, torbernite, uranophane, and a calcium-uranium-oxide mineral (analogue of fluorite): 495.
V.C.A. properties: 532.
Schroeckingerite Occurrences—
Marysvale area: 267, 522; in veins with other secondary uranium minerals and pitchblende: 493.
Bullion-Monarch mine: with autunite, meta-torbernite, pitchblende, torbernite, uranophane: 495.
East Slope No. 2 deposit: with autunite, meta-torbernite, uranophane along face of open-cut coating fractures and joints in hornfels: 493.
Freedom No. 1 (Seegmiller) mine: with autunite, torbernite, trace of pitchblende: 495.
Freedom No. 2 mine: with autunite, torbernite, uranophane: 495.
Prospector mine: fluorescent mineral with properties characteristic of schroeckingerite in quartz monzonite uranium-bearing zones: 447.
Torbernite Occurrences—
Marysvale area: 267, 522; in veins with other secondary uranium minerals and pitchblende: 493; with autunite and uraninite: 411.
Bullion Monarch mine: with autunite, meta-torbernite, pitchblende, schroeckingerite, uranophane: 495.
Bullion Monarch Mining Co.: properties: 532.
Freedom No. 1 (Seegmiller) mine: with autunite, trace of pitchblende, schroeckingerite: 495.
Freedom No. 2 mine: with autunite, schroeckingerite, uranophane: 495.
Prospector mine under lease by V.C.A.: with pitchblende, a calcium-uranium-oxide mineral (analogue of fluorite), autunite, uranophane: 495.
V.C.A. properties: 532.
Uraninite Occurrences—
Marysvale area: 48, 53, 267, 547; fine grained mixed sample examined by X-ray fluorescence method giving partial chemical analysis: 448; in various mines and prospects, associated with secondary uranium minerals: 522; mineralogical studies of specimens: 445; mostly in veins in quartz monzonite or fine-grained granite: 450; with autunite and torbernite: 441.
Bullion Monarch mine: uranite in small amounts and in drill holes in vicinity: 451.
Prospector mine: in quartz monzonite, clay, and breccias: 447; sooty black uraninite mixed with fine-grained pyrite and fluorite within 60 ft. of surface: 451.
V.C.A. properties: 532.
Uranium Development—
Marysvale area: 530.
Santa Fe Railway land: 73.
Uranium Exploration—
Marysvale area: airborne radioactivity reconnaissance: 451; Geiger counter ground survey: 451; scintillometer ground survey: 451; U.S.A.E.C. office closed: 554.
Uranium Occurrences—
Marysvale area: alteration zones showing a sequence of clay minerals, silicification, alunitization, or pyritization: 450; analysis of relationship between alteration and uranium mineralization: 450; autunite: 526; autunite, processed: 548; autunite, schroeckingerite, torbernite, uraninite, etc.: 267; autunite, some uraninite; 175 t. ore shipped daily: 547; economic deposits of primary and secondary uranium minerals in altered vein structures: 493; geology: 451, 495; geology and descriptions of uranium mines: 522; mapping an aid in establishing the correlation between alteration and rock types: 450; mineralization: 451; more significant channels of alteration mapped: 450; origin of deposits: 451; pitchblende: 102; pitchblende and secondary uranium minerals in structurally controlled uranium deposits: 443; pitchblende in veins of the fluorite-sulfide-quartz type: 455; radioactivity: 451; recent ore shipments assayed 0.8% U_3O_8: 441; rock alteration: 451; structure: 451, 495; U.S.A.E.C. uranium ore purchasing depot operated by A. S. & R. Co. at Marysvale: 53, 441, 525, 526, 531; sampling methods and pricing described: 522; uraninite: 48, 53; uraninite and secondary uranium minerals in various mines and prospects: 522; uraninite, autunite, torbernite: 441; uraninite, fine grained mixed sample examined by X-ray fluorescence method giving partial chemical analysis: 448; uraninite, mineralogical studies of specimens: 445; uranium development: 530; uranium mineral deposits: 495; uranium ore purchase schedule for typical autunite-torbernite ores: 522; uranium production: 77; uranium-bearing veins with both oxidized uranium minerals and uraninite and fluorite, mostly in quartz monzonite or fine-grained granite, with some uranium in Bullion Canyon volcanic series in argillic alteration zones,

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and migratory secondary uranium mineralization along fractures in Mt. Belknap volcanics: 450; weathering produced following zonation of uranium minerals: autunite, schroeckingerite, torbernite, and uranophane at surface, zone dominantly uranophane with abundant autunite and torbernite in lower parts, then zone with sooty pitchblende and relict masses of primary pitchblende: 493.
Antelope Range, high elevation on W slope: alteration zone in rhyolite showed no significant uranium mineralization: 447.
Buddy claim, Bertelson's deposit: autunite: 479.
Buddy mine: autunite, a little pitchblende: 495; mineralization: 495; pitchblende: 429; rock types: 495; structure: 495.
Bullion Monarch mine: mineralization: 495; pitchblende, autunite, meta-torbernite, schroeckingerite, torbernite, uranophane: 495; rock types and alteration: 495; structure: 495; uraninite in small amounts and in drill holes in vicinity, autunite: 451; uranium minerals: 429.
Bullion Monarch open pit on west side of Pratt Peak: first uranium mineralization in area found there over 60 years ago and rediscovered by Pratt Seegmiller in 1940; 522; equipment owned and operated by Atherley brothers for Bullion Monarch Mining Co.: 522; largest producer in area: 522; schroeckingerite in rhyolite and secondary uranium mineralization between rhyolite and crushed, gougey contact: 522.
Bullion Monarch Mining Co. operations: autunite ore easy to mill and reduce: 526; firm has indicated reserves of 500,000 t. autunite with U_3O_8 content on total tonnage ranging from 0.7–0.26%: 526.
Bullion Monarch Mining Co. properties: autunite, torbernite: 532; new autunite cut: 552; uranium shipments: 552.
Bullion Monarch prospect: uranium in open cuts along contact between Mt. Belknap rhyolite and quartz monzonite: 447.
Claims of D. MacIntosh and J. Henry, 1½ mi. W of Marysvale: uranium: 527.
East slope claims: autunite etc.: 429.
East Slope No. 2 deposit: autunite, meta-torbernite, schroeckingerite, and uranophane, distributed along face of open cut in two main zones about a core of hematite-alunite-quartz-kaolinite rock: 493; secondary uranium minerals associated with alunitic and clay alteration zones in veinlike structure within hornfels: 493.
Farmer John claims: owned by John Sargeant and leased by Bullion Monarch Mining Co. for fluorite mining and, later for uranium development: 522.
Farmer John claims of Bullion Monarch Mining Co. near Marysvale: uranium: 541; uranium mineralization with fl... rite: 522.
Farmer John open pit, Bullion Monarch Mining Co.; autunite, pitchblende: 47...
Freedom claims located by Pratt Seegmiller in 1948: autunite with some tor... bernite: 522.
Freedom lease, V.C.A.: autunite, pitch... blende: 479.
Freedom No. 1 (Seegmiller) mine: auto... nite, trace of pitchblende, schroeckin... erite, torbernite: 495; mineralizatio... 495; rock types and alteration: 49... structure: 495.
Freedom No. 2 mine: autunite, schroeck... ingerite, torbernite, uranophane: 49... autunite, uranophane in fractures i... rhyolite: 451; mineralization: 495; mos... important producer of secondary ura... nium ore in district: 495; rock types 495; structure: 495; uranium mineral... 429.
Freedom prospect: hydrothermal alter... tion and uranium mineralization i... quartz monzonite: 447.
J. and L. alunite mine: uranium-bearing material similar to opal in adit ha... unusual green fluorescence like that o... some hyalite: 451.
Opal, Uranium-bearing—
J. and L. alunite mine: in adit: 451.
Trinity mine: in old workings: 451.
Papsy's Hope prospect owned by J. D. Fullmer: autunite on fracture surfaces in altered feldspar porphyry, a part o... the Bullion Canyon volcanics: 44... autunite samples contain 0.013-0.030... eU: 442; autunite, etc.: 429; uranophane as zone forming halo overlying autunite-bearing vein and underlying leached clay: 451; geology: 442; rock alteration and silicification: 442.
Prospector group of claims located by April Smith, and L. J. and Merl... Anderson: uranium located in shear zone: 522; leased by V.C.A. for develop... ment along with Seegmiller's claims (... Freedom and Freedom No. 1 mines 522.
Prospector lease, V.C.A.: autunite, pitch... blende: 479.
Prospector mine under lease by V.C.A.: alteration in quartz monzonite shows increased argillic alteration as uranium-bearing zones are approached: 45... mineralization: 495; mineralogical stud... ies on quartz monzonite sample by thin section, X-ray diffraction, differential thermal analysis, and electron micro... scope examination methods: 447; pitch... blende: 429; pitchblende, a calcium uranium-oxide mineral (analogue of fluorite), autunite, torbernite, uranophane: 495; pitchblende in black, sooty and massive form: 495; quartz mon... zonite has andesine, biotite, epidote, olivine, orthoclase, quartz, sphene, and zircon with secondary introduction of alunite, fluorite, pyrite, and uraninite as well as quartz, mixture of quartz and feldspar, and sericite: 447; structure

495; rock types: 495; sooty black uraninite mixed with fine-grained pyrite and fluorite within 60 ft. of surface: 451; uraninite, disseminated with pyrite, limonite, and some schroeckingerite in quartz monzonite: 447; uranium deposits entirely in quartz monzonite in parts showing alteration effects: 447; uranium-bearing breccia covered with black sooty uraninite and associated with pyrite, fluorite, and uraninite: 447; uranium-bearing clay containing uraninite associated with pyrite and limonite and a little secondary fluorite and alunite: 447.
Sniffer claims: uranium minerals: 429.
Trinity mine: uranium-bearing opal in old workings; has brilliant green fluorescence: 451.
V.C.A. claims: autunite: 523.
V.C.A. properties: autunite, pitchblende, torbernite, uraninite: 532.
Yellow Canary prospect: autunite, uraophane (?): 495; mineralization: 495; rock types and mineralization: 495; structure: 495.
Uranium Ore Guides—
Geobotanical Guides—
Analyses of plants growing on uranium-bearing rocks and soils and showing uranium content in ppm. along with vanadium, selenium, and lead content: Marysvale: 409.
General indicator plant, *Purshia tridentata*: Marysvale: 409.
One sulphur-selenium indicator plant: Marysvale: 409.
Only three selenium-indicator plants: Marysvale: 409.
Geologic Guides—
Associated black or purple fluorite: Marysvale: 451.
Clay zones (argillic alteration): Marysvale: 451.
Iron-staining in uranium-bearing veins: Marysvale: 451.
Radioactive anomalies: Marysvale: 451.
Rock alteration: Marysvale: 451.
Uranium Processes—
Marysvale area: U.S.A.E.C. uranium ore purchasing depot and ore sampling station operated by A. S. & R. Co. at Marysvale: 53, 441, 525, 526, 531; sampling methods and pricing described: 522.
Uranium Production—
Marysvale area: 77; autunite, processed at Vitro qualified uranium mill (Kalunite plant), Salt Lake City: 548; U.S.A.E.C. uranium ore purchasing depot and ore sampling station operated by A. S. & R. Co. at Marysvale: 53, 441, 525, 526, 531; sampling methods and pricing described: 522; uranium produced in several mines and prospects: 522; 175 t. ore shipped daily: 547; uranium processing plant may be built if ore is found in sufficient quantities: 525.
Bullion Monarch Mining Co. property: shipped ore averaging over 0.2% U_3O_8: 552.
Central Mining area—
Buddy mine: 451.
Bullion Monarch mine: 451.
Freedom No. 1 (Seegmiller) mine: 451.
Freedom No. 2 mine: 451.
Prospector mine: 451.
Farmer John open pit, Bullion Monarch Mining Co.: autunite: 479.
Freedom claims, V.C.A.: autunite: 479.
Prospector lease, V.C.A.: only producer of pitchblende: 479.
Uranium Purchases—
Marysvale: U.S.A.E.C. uranium ore-buying station: 53, 441, 525, 526, 531; uranium ore purchase schedule for typical autunite-torbernite ores: 522.
Uranophane Occurrences—
Marysvale area: in veins with other secondary uranium minerals and pitchblende: 493.
Bullion Monarch mine: with pitchblende, autunite, meta-torbernite, schroeckingerite, torbernite: 495.
East Slope No. 2 deposit: with autunite, meta-torbernite, schroeckingerite along face of open-cut coating fractures and joints in hornfels: 493.
Freedom No. 2 mine: with autunite, schroeckingerite, torbernite: 495; in fractures in rhyolite NW of and in upper reaches of mine: 451.
Papsy's Hope prospect: as zone about 2 ft. thick forming halo overlying autunite-bearing vein and underlying leached clay: 451.
Prospector mine under lease by V.C.A.: with pitchblende, a calcium-uranium-oxide mineral (analogue of fluorite), autunite, torbernite: 495.
Yellow Canary prospect: questionable occurrence with autunite: 495.
Radioactive Fluorite
See under individual county names and under Index III, Radioactive Fluorite—Utah: 405.
Radioactive Occurrences
See under individual county names and under Index III, Radioactive Occurrences—Utah: 21.
Radium Occurrences
See under individual county names and under Index III, Uranium Occurrences—Utah: 503.
Radium Production
See under individual county names and under Index III, Radium Production—Utah: 7, 415.
Salt Lake County
Monazite Occurrences—
Salt Lake City: 217.
Thorium Occurrences—
Salt Lake City: monazite: 217.
Uranium Exploration—
Salt Lake City: U.S.A.E.C. office opened: 549, 554.
Uranium Processes—
Salt Lake City: qualified uranium mill (Kalunite plant) of Vitro Chemical Co.: 497, 546; processes Marysvale autunite: 548; processes 100 t. Marysvale ores daily: 547; to process Wyoming ores: 384.
Uranium Production—
Salt Lake City: qualified uranium mill (Kalunite plant) of Vitro Chemical Co.: 497, 546; processes Marysvale autunite:

UTAH (contd.)
548; processes 100 t. Marysvale ores daily: 547; to process Wyoming ores: 384.
San Juan County (Colorado Plateau)
Bayleyite Occurrences—
*Hideout No. 1 mine on Deer Flats, N side of White Canyon: with schroeckingerite in adit 100 ft. from cliff face: 490.
Becquerelite Occurrences—
White Canyon: 401.
Beta-Uranotil Occurrences—
**Grey Dawn mine, operated by Ace Turner, on small tributary of La Sal Creek near SW flank of La Sal Mts.: three pod-like occurrences with carnotite, gummite, uraninite: 480.
Carbonaceous Deposits, Uranium-bearing—
White Canyon: 401.
Carnotite Occurrences—
Abajo Mts.: 404.
Big Indian Valley, N of Monticello: 78, 82.
Browns Hole area: 396.
Cane Springs Pass S of Moab: 34.
Bridger Jack Flat: 437.
Cottonwood Canyon District—
Basin claim: ore horizon in sandstone drilled by U.S.B.M.: 440.
Big Hole mine, largest in district and owned by Blanding Mines Co.: carnotite in layers in sandstone, drilled by U.S.B.M.: 440.
Birthday, Shale, East Bank, Found No. 2, and Lost claims: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Blue Bird area, about 1½ mi. W of Cliff-house claim and owned by V.C.A.: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Hangover Nos. 1 and 2 and Ridge Nos. 1 and 2 claims, on small tributary of Cottonwood Creek: carnotite in massive, thick, lenticular sandstone, drilled by U.S.B.M., and showing from zero to less than 0.05% U_3O_8: 440.
Dry Valley: in Morrison formation: 415.
Dry Valley, N of Monticello: 78, 82.
East Canyon: with tyuyamunite: 82.
Grey Dawn mine: with beta-uranotil, gummite, uraninite; lenticular pod-like structure, parallel to dip of Salt Wash sandstone beds: 480; structure, lenticular, irregular ore pods: 480; origin of ore, possibly alteration of hydrothermal ore deposits: 480.
La Sal Mountains: 396.
Lisbon (not Lisburne) Valley, N of Monticello: 78, 82.
Montezuma Canyon: 503.
Monument Valley: 63, 427.
Navajo Indian Reservation: 161.
White Canyon District—
White Canyon: 63; 8 mi. from Hite: 78.
Happy Jack mine: carnotite in thin seam, drilled by U.S.B.M., and showing no U_3O_8 so work was to be abandoned: 440.
Yellow Circle Group—
White Fawn and Yellow Circle claims: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from zero to 5.20% U_3O_8: 440.
Carnotite Processes—
Monticello: qualified uranium mill owned by U.S.A.E.C. and operated by the Galigher Co. treats 100 t. carnotite per day: 461; leaching process: 408; treatment methods and equipment described: 461; treats four types of uranium ores, rejects from the sampling plant: low vanadium-low lime, high vanadium-low lime, low vanadium-high lime, high vanadium-high lime: 461; original processing plant operated by V.C.A. during World War II for production of uranium and vanadium: 461; uranium ore sampling plant owned by U.S.A.E.C. and operated by A. S. and R. Co. acting as its sampling and ore buying agents: 461.
White Canyon District: pilot treatment plant: 140, 538; pilot plant to treat ore from Navajo Indian Reservation: 140.
Copper-Uranium Deposits—
White Canyon District—
White Canyon: uranium and copper minerals in Shinarump conglomerate as disseminated deposits in sandstone and as veins along fractures, sometimes as replacements in logs; similar deposits of lower grade in Chinle formation and in Moenkopi formation: 401; geology: 401; grade: 401; localization of deposits by uranium ore guides: 401: chemical controls: 401, general geologic controls: 401, relation to channel fills: 401, structural controls: 401; mineralogy: 401; origin: 401; production: 401; structure: 401.
Ace of Hearts claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bankrupt claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bear claim: copper-uranium deposit with 0.05–0.1% U>401.
Bell claim: copper-uranium deposit with 0.1–0.3% U: 401.
Bridges claim: copper-uranium deposit with 0.01–0.05% U: 401.
Butler's claim: copper-uranium deposit with 0.05–0.1% U: 401.
Cub claim: copper-uranium deposit with 0.05–0.1% U: 401.
Dead Buck claim: copper-uranium deposit with 0.05–0.1% U: 401.
Found claim: copper-uranium deposit with 0.1–0.3% U: 401.
Four Aces claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey Canyon No. 4 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Frey claim: copper-uranium deposit with 0.05–0.1% U: 401.
Frey No. 1 claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey No. 2 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Gonaway-North Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Happy Jack mine: copper-uranium deposit with more than 0.3% U: 401.

* Hereafter cited as Hideout No. 1 mine.
** Hereafter cited as Grey Dawn mine.

Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Hideout No. 1 mine: in Shinarump conglomerate: 490.
Jacobs Chair claim: copper-uranium deposit with 0.05–0.1% U: 401.
Jerry claim: copper-uranium deposit with 0.05–0.1% U: 401.
Markie claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback (Old Jackpot) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Notch claim: copper-uranium deposit with 0.01–0.05% U: 401.
Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Posey mine: copper-uranium deposit with more than 0.3% U: 401.
Red Canyon No. 1 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Saddle claim: copper-uranium deposit with 0.01–0.05% U: 401.
Scenic No. 2 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Scenic No. 4 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scotty claim: copper-uranium deposit with 0.01–0.05% U: 401.
Standard claim: copper-uranium deposit with less than 0.01% U: 401.
Sunrise claim: copper-uranium deposit with 0.01–0.05% U: 401.
Unknown claim: copper-uranium deposit with less than 0.01% U: 401.
Uracop claim: copper-uranium deposit with 0.01–0.05% U: 401.
W.G.J.N.W. claim: copper-uranium deposit with less than 0.01% U: 401.
W.N. claim: copper-uranium deposit with 0.01–0.05% U: 401.
White Canyon No. 1 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Woodenshoe (?) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Yellow John claim: copper-uranium deposit with more than 0.3% U: 401.
Zebra claim: copper-uranium deposit with less than 0.01%: 401.
White Canyon-Red Canyon District: 20.
Geophysical Exploration (Airborne)—
Blanding: first low-altitude operation; done by Texas Co. in 1950: 494.
Cataract Canyon: airborne survey by Excalibur Uranium Corp. in 1951: 494.
Red Canyon District: airborne survey by Anaconda Mining Co. cooperating with Rigg Aviation Service, in 1951: 494.
Gummite Occurrences—
Grey Dawn mine: three pod-like occurrences with beta-uranotil, carnotite, uraninite: 480.
Johannite Occurrences—
White Canyon District—
White Canyon: 401.
Happy Jack mine: with chalcanthite at surface: 493.
Pitchblende Occurrences—
White Canyon District—
White Canyon: deposits in sedimentary rocks replacing cell walls of fossil plants while copper sulfides fill cells: 485; dissemination associated with copper sulfides and secondary uranium minerals in sandstone in Shinarump conglomerate: 455.
Happy Jack mine: 401, 412; in copper-uranium deposit in mine workings 75 ft. underground: 509; in interior of deposit: 493.
Hideout mine: 401.
Posey mine: 401.
Phosphuranylite Occurrences—
White Canyon: 401.
Radium Occurrences—
Montezuma Canyon: uranium and radium in silts in canyon floor: 503.
Schoepite Occurrences—
White Canyon: 401.
Schroeckingerite Occurrences—
White Canyon District—
Hideout No. 1 mine: with bayleyite in adit 100 ft. from cliff face: 490.
Sediments, Radium-bearing—
Montezuma Canyon: in silts on Canyon floor: 503.
Sediments, Uranium-bearing—
Montezuma Canyon: in silts on canyon floor: 503.
Torbernite Occurrences—
La Sal Mts.: 82.
White Canyon District—
White Canyon: 401.
Happy Jack mine: with uranophane starting just below surface: 493.
Tyuyamunite Occurrences—
East Canyon: with carnotite: 82.
Uraninite Occurrences—
Grey Dawn mine: origin, possibly hydrothermal; not placer or detrital: 480; structure, lenticular, irregular ore pods: 480; three pod-like occurrences with beta-uranotil, carnotite, gummite: 480.
White Canyon District—
Happy Jack mine: 48.
Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Uranium Exploration—
Bowles-Heflin Mining Co. program: government grant for exploration: 556.
Blanding-Cottonwood area: diamond drilling: 154.
Geophysical Exploration (Airborne)—
Blanding: first low-altitude operations; done by Texas Co. in 1950: 494.
Cataract Canyon: airborne survey by Excalibur Uranium Corp. in 1951: 494.
Red Canyon district: airborne survey by Anaconda Mining Co. cooperating with Rigg Aviation Service, in 1951: 494.
Uranium Occurrences—
Abajo Mts.: carnotite: 404; uranium in ore deposits forming haloes around mountain masses with bleached sandstone surrounding orebodies: 481.
Abe Day's Vanadium Queen claim: uranium oxide, production: 544; eligible for U.S.A.E.C. Bonus: 544.
Big Indian Valley N of Monticello: carnotite: 78, 82.

UTAH (contd.)
Big Indian Wash—
Mi Vida mine, on Mi Vida claim and owned by Charles Steen: heavy black ore resembling pitchblende and uraninite with no carnotite found in belt 72 ft. below the surface; assay of core gave 0.34 to 5% U_3O_8: 465; Utex Exploration Co. formed, with Steen and his mother as principal stockholders, to develop mine and adjacent claims: 465; first ore shipment made Dec. 1952 and total ore shipped increased to $1,000,000's worth by Aug. 1953: 465; ore found on other parts of Mi Vida claim averaged better than 0.50% U_3O_8 with some as rich as 21% and hand-picked samples ranging up to 88%: 465; Steen stockpiling all ore above 20% in hopes of collecting A.E.C. bonus for first 20 t. of non-carnotite, non-roscoelite ore assaying at least 20% discovered in U.S.: 465; high lime content only disadvantage of Steen ore, which is being stored at Monticello mill until proper treatment facilities become available for extraction of its uranium: 465.
Other uranium claims in area near Mi Vida claim: uranium deposits being developed by owners or under leases to companies and individuals: 465.
Browns Hole area: carnotite: 396.
Bull Canyon area: uranium claims: 524.
Cane Springs Pass S of Moab: carnotite: 34.
Bridger Jack flat: carnotite: 437.
Cottonwood Canyon District—
Basin claim: ore horizon in sandstone, drilled by U.S.B.M.: 440.
Big Hole mine, largest in district and owned by Blanding Mines Co.: carnotite in layers in sandstone, drilled by U.S.B.M.: 440.
Birthday, Shale, East Bank, Found No. 2, and Lost claims: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Blue Bird area, about 1½ mi. W of Cliffhouse claim and owned by V.C.A.: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Hangover Nos. 1 and 2 and Ridge Nos. 1 and 2 claims, on small tributary of Cottonwood Creek: carnotite in massive, thick, lenticular, sandstone, drilled by U.S.B.M., and showing from zero to less than 0.05% U_3O_8: 440.
Dry Valley: carnotite in Morrison formation 415.
Dry Valley N of Monticello: carnotite: 78, 82.
East Canyon: carnotite, tyuyamunite: 82.
Elk Ridge anticline: uranium in isolated orebodies on large anticlines and domes: 481.
Grey Dawn mine: uraninite, assaying about 64% U_3O_8: 480; uraninite, associated with carnotite ores of Salt Wash sandstone member of Morrison formation: 480; uraninite, in three pod-like occurrences: 480; uraninite with beta-uranotil, carnotite, gummite: 480.
La Sal Mountains: carnotite: 396; torbernite: 82; uranium in ore deposits forming haloes around mountain masses with bleached sandstone surrounding orebodies: 481.
Lisbon (not Lisburne) Valley N of Monticello: carnotite: 78, 82.
Monument Valley: all uranium deposits found to date occur in channels in Shinarump formation: 481; carnotite: 63, 427; uplift: uranium in isolated orebodies on large anticlines and domes: 481.
Skyline mine: uranium in channels in Shinarump formation: 481.
Whirlwind mine: uranium in channels in Shinarump formation: 481.
Montezuma Canyon: carnotite: 503; uranium and radium in silts on canyon floor: 503.
Navajo Indian Reservation: carnotite: 161; Navajos may reassign uranium mining rights: 178.
Navajo Mt.: uranium: 169.
Spanish Valley anticline, NW faulted segment: uranium in isolated orebodies on large anticlines and domes: 481.
White Canyon District—
White Canyon: 411; carnotite: 63; copper-uranium deposits in Shinarump conglomerate as disseminated deposits in sandstones and as veins along fractures, sometimes as replacements in logs; similar deposits of lower grade in Chinle formation and in Moenkopi formation: 401; geology: 401; grade: 401; localization of deposits by uranium ore guides: 401: chemical controls: 401, geologic controls: 401, relation to channel fills: 401, structural controls: 401; mineralization, pitchblende, secondary uranium minerals including johannite, phosphuranylite, schoepite-becquerelite, torbernite, uranophane, and zippeite, and uranium in carbonized wood, iron and manganese oxides, and veinlets of hydrocarbon: 401; mineralogy: 401;
Ore Criteria—
Features apparently unrelated to ore deposits: conglomerate: 401; freckled limonite: 401; hydrous mica: 401; massive sandstone: 401; these have served as prospecting guides in other areas but have not been useful in White Canyon and are considered unimportant in finding concealed deposits: 401.
Features found only in mineralized areas: alunite (?): 401; hydrocarbons: 401; secondary copper sulfates and carbonates: 401; sulfide minerals: 401; visible uranium minerals: 401.
Features found in unmineralized as well as mineralized areas: association of several features may indicate favorable prospecting areas: 401; bleaching and alteration of Moenkopi formation: 401; carbonized wood fragments and vegetal material: 401; channel filling: 401; facies change within Shinarump conglomerate: 401; fracturing: 401;

iron and manganese staining: 401; jarosite (?): 401;
origin: 401; pitchblende disseminated in Shinarump conglomerate and associated with copper sulfides, a little cobalt, and secondary uranium minerals in sandstone: 455; pitchblende in sedimentary rocks, replacing cell walls of fossil plants while copper sulfides fill cells: 485; production: 401; structure: 401; 8 mi. from Hite: carnotite: 78.
Ace of Hearts claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bankrupt claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bear claim: copper-uranium deposit with 0.05–0.1% U: 401.
Bell claim: copper-uranium deposit with 0.1–0.3% U: 401.
Bridges claim: copper-uranium deposit with 0.01–0.05% U: 401.
Butler's claim: copper-uranium deposit with 0.05–0.1% U: 401.
Cub claim: copper-uranium deposit with 0.05–0.1% U: 401.
Dead Buck claim: copper-uranium deposit with 0.05–0.1% U: 401.
Found claim: copper-uranium deposit with 0.1–0.3% U: 401.
Four Aces claim: copper-uranium deposit with 0.01–0.05% U: 401.
Four Aces mine in White Canyon: radioactive asphaltite pellets: 509.
Frey Canyon No. 4 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Frey claim: copper-uranium deposit with 0.05–0.1% U: 401.
Frey No. 1 claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey No. 2 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Gonaway-North Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Happy Jack mine: carnotite in thin seam, drilled by U.S.B.M., and showing no U_3O_8, so work was to be abandoned: 440; channel structure: 412; copper-uranium deposit grading laterally from secondary uranium carbonates and sulfates at exposed cliff face to sulfides and pitchblende at mine workings 75 ft. underground: 509; copper-uranium deposit with more than 0.3% U: 401; geology: 412; horizontal bedding-plane control for pitchblende: 466; johannite associated with a large suite of secondary uranium minerals: 493; mineralogy: 412; no evidence of vertical control of primary ore: 466; origin: 412; pitchblende etc.: 412; sequence of secondary uranium minerals from leached outcrop shows johannite and chalcanthite at surface, uranophane and torbernite a short distance in, and pitchblende, pyrite, chalcopyrite, chalcocite, and gersdorffite in interior: 493; stratigraphy: 412; uraninite: 48; uranium in channels in Shinarump formation and with bleached mudstone in Chinle formation: 481; uranium ore usually in porous carbonaceous sandstone above Shinarump siltstone: 466; uranium: ore deposition controlled by channels in Shinarump formation with carbonaceous matter and lithologic changes as intrachannel controls: 466; uranium production: 412.
Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Hideout No. 1 mine: bayleyite, schroeckingerite, in adit 100 ft. from cliff face: 490; copper-uranium deposit in Shinarump conglomerate: 490.
Jacob's Chair claim: copper-uranium deposit with 0.05–0.1% U: 401.
Jerry claim: copper-uranium deposit with 0.05–0.1% U: 401.
Markie claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback (Old Jackpot) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Notch claim: copper-uranium deposit with 0.01–0.05% U: 401.
Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Posey mine: copper-uranium deposit with more than 0.3% U: 401.
Red Canyon No. 1 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Saddle claim: copper-uranium deposit with 0.01–0.05% U: 401.
Scenic No. 2 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Scenic No. 4 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scotty claim: copper-uranium deposit with 0.01–0.05% U: 401.
Standard claim: copper-uranium deposit with less than 0.01% U: 401.
Sunrise claim: copper-uranium deposit with 0.01–0.05% U: 401.
Sunrise and Gonaway claims: uranium ore deposition controlled by channels in Shinarump formation with carbonaceous matter and lithologic changes as intrachannel controls: 466; uranium ore usually in porous carbonaceous sandstone above Shinarump siltstone: 466.
Unknown claim: copper-uranium deposit with less than 0.01% U: 401.
Uracop claim: copper-uranium deposit with 0.01–0.05% U: 401.
W.G.J.N.W. claim: copper-uranium deposit with less than 0.01% U: 401.
W.N. claim: copper-uranium deposit with 0.01–0.05% U: 401.
White Canyon No. 1 claims: copper-uranium deposit with 0.1–0.3% U: 401.
Woodenshoe (?) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Yellow John claim: copper-uranium deposit with more than 0.3% U: 401.
Zebra claim: copper-uranium deposit with less than 0.01% U: 401.
White Canyon-Red Canyon District: copper-uranium deposit: 20.
Yellow Circle Group—
White Fawn and Yellow Circle claims: carnotite in sandstone lenses, drilled by

UTAH (contd.)
U.S.B.M., and showing from zero to 5.20% U_3O_8: 440.
Uranium Ore Guides—
Geologic Guides—
Bleaching of sandstone: Abajo and La Sal Mts.: 481.
Presence of fossil stream channels: Monument Valley in Shinarump formation: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around the mountain groups at distances proportional to the mass of the mountains: Abajo Mts.: 481; La Sal Mts.: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated bodies at irregular intervals from crest of structure outward to base of its flanks: Elk Ridge anticline: 481; Monument Valley uplift: 481; Spanish Valley anticline NW faulted segment: 481.
Thickness of ore-bearing sandstone: Blanding District: 465.
White Canyon District—
Bleaching of mudstone: Chinle formation at Happy Jack mine, White Canyon: 481.
Channels in Shinarump formation: White Canyon, Utah: 466; channels first mapped here in 1951 by outcrop mapping alone: 466; three channels explored and extended by drilling (Happy Jack, Sunrise, and Gonaway): 466; with carbonaceous matter and lithologic changes as intrachannel controls: 466.
Chemical Controls: White Canyon: 401.
Geologic Controls: White Canyon: 401.
Ore Criteria, features apparently unrelated to ore deposits: conglomerate: 401; freckled limonite: 401; hydrous mica: 401; massive sandstone: 401; these have served as prospecting guides in other areas but have not been useful in White Canyon and are considered unimportant in finding concealed uranium deposits: 401.
Ore Criteria, features found only in mineralized areas: alunite (?): 401; hydrocarbons: 401; secondary copper sulfates and carbonates: 401; sulfide minerals: 401; visible uranium minerals: 401.
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Long Park: camps of Radium Co. of Colorado and Radium Luminous Materials Corp.: 407; carnotite mining carried out in open cuts, tunnels, and inclines: 407; carnotite ore production about 5 t. per day: 407; total shipping production of about 4200 t. carnotite ore averaging 2% U_3O_8 in McElmo formation: 407; Uravan mineral belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Maggie C claim, Long Park: 34.
Monogram Camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; in Morrison formation: 415; mining operations were carried on by hand: 407; three adits worked and several carnotite orebodies present: 407.
Outlaw camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Paradox Creek: in sandstone: 78, 82.
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Shamrock group including Shamrock and Old Salt Lick claims, owned by U.S. Vanadium Co.: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from less than 0.05 to 1.43% U_3O_8: 440.
Roc Creek: 439; in sandstone: 78, 82.
Copper Prince claim: 473.
Roc Creek Mining District: 241.
Sinbad Valley: 435, 439, 459.
Uravan: deposits in Morrison formation: 417.
Vixen Mining District: 241.
Park County—
Fairplay area: in Upper Morrison formation: 53.
Garo: with volborthite, associated with uraniferous carbonaceous shale and carbonized plant fossils, in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Rio Blanco County—
Coal Creek: 34, 422.
Coal Creek, 14 mi. NE of Meeker: 78, 82.
Caywood claims: 423.
Coal Creek Mining District: 241.
J. Mackay mine No. 2 specimens: concentration process results: 418; mineralogy: 418.
Meeker: 511; in Morrison formation: 509.
Routt County—
General: 82.
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Cedar Mining District: 241.
Disappointment Creek near Cedar: 78, 82.
Egnar-Slick Rock District—
Buckhorn and Cone claims: carnotite in rolls and a log, drilled by U.S.B.M., and showing from less than 0.05 to 1.74% U_3O_8: 440.
Hawk Nos. 1 and 2 and Frankie No. 1 claims: carnotite in rolls, drilled by

U.S.B.M., and showing from none or less than 0.05 to 2.62% U_3O_8: 440.
Hogback and Marie claims in Bishop and Summit Canyons: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Radium No. 2 and adjoining claims: carnotite in large orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 7.55% U_3O_8: 440.
Radium No. 4 claim: produced 325 t. ore with 1.75% V_2O_5 but U.S.B.M. drilling gave blank holes; ore in rolls: 440.
Radium No. 6 claim: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 7.00% U_3O_8: 440.
Uncle Sam and Mucho Grande claims: carnotite in lenticular orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Charles T Group:
Fraction No. 1 and Summit claims: carnotite in sandstone, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 2.13% U_3O_8: 440.
Legin Group:
Frenchy, King, King No. 2, May, and Sam claims: carnotite in elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.92% U_3O_8: 440.
Lower Group:
Cougar, Last Chance, Little Mariel, and Rainbow claims: carnotite in large elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.80% U_3O_8: 440.
Gypsum Valley District—
Gypsum Valley: 416.
Gypsum Valley, Disappointment District: 439.
Jack Knife claim: carnotite in a roll, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Lost claim: carnotite in thin layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.25% U_3O_8: 440.
Main Street claim: carnotite in layers and small rolls, drilled by U.S.B.M., and showing less than 0.05% U_3O_8 in one hole and blanks in two others: 440.
Pay Day claim: carnotite in two blanket-like layers of ore, drilled by U.S.B.M, and showing less than 0.05% U_3O_8: 440.
Pitchfork claim: carnotite in layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.10% U_3O_8; 440.
Riverview claim: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.33% U_3O_8: 440.
McIntyre District: in Morrison formation: 415.
Placerville: 78, 82, 435, 439, 459; with roscoelite in Entrada formation: 509.
Snyderville Mining District: 241.
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General: 20, 405, 444.
Accessibility: 440.
Colorado: carnotite field in southwest part of state: 407; small, widely scattered deposits: 457; deposits in Morrison formation stratigraphically controlled: 443.
Deposits in Arizona, Colorado, New Mexico and Utah: 441; spotty, scattered, average 0.25% U_3O_8, and occur in Salt Wash member of the Morrison formation, Shinarump conglomerate, and Entrada sandstone: 501.
Deposits in Colorado, New Mexico, and Utah: 407.
Deposits in Morrison formation: 440.
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Exploration by U.S.B.M.: 440.
Geology: 407, 431, 440.
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History: 440.
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Origin: 13, 22, 407, 431; deposition by solution: 444.
Physiography: 440.
Property and ownership: 440.
Salt Wash formation: 63.
Sampling and metallurgy work on drill cores: 440.
Shinarump conglomerate: 22.
U.S.G.S. drilling program produced geologic logs of which study led to formulation of geologic guides to carnotite deposits: 501.
U.S.A.E.C.'s buying schedule and policies for carnotite ore: 441.
Uranium mills: 407, 440.
Utah: carnotite in eastern parts: 407; small, widely scattered deposits: 457.
Work of small scale operators: 431.
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Morrison Formation
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Origin: 13, 22; probably syngenetic in Shinarump conglomerate and at Silver Reef: 415.
Shinarump conglomerate: 22.

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Colorado Plateau—
General: 22; deposits in Salt Wash member of Morrison formation, scattered erratically over Arizona, Colorado, New Mexico, and Utah: 431; small widely scattered deposits; U_3O_8 content 0.1 to 0.3%: 457.
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Browns Park: 34.
Red Creek: 78.
Emery County—
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Green River: 433, 511; specimens: concentration process results: 418; specimens: mineralogy: 418.
San Rafael Swell: 41, 63, 404, 410, 425, 436, 459; 18 mi. W of Green River: 78; with tyuyamunite: 82; near Tidwell: 433.
San Rafael Mining District: 241.
Temple Mountain: 416, 425, 436, 438; as coating on asphaltite pellets: 509; derived from asphalt, which may be thucholite in this area: 509; S of Green River: 545.
Temple Rock: 34, 78; with tyuyamunite: 82.
South Temple Wash: 82.
Table Mountain: 511.
Wildhorse Canyon: 404, 433.
Garfield County—
Circle Cliffs: 63; with carbonized wood and radioactive iron oxide as uranium-bearing materials in copper-uranium deposit in Triassic Shinarump conglomerate: 509.
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Trachyte District: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Blitz Nos. 1–7 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
June Bell Nos. 1–4 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Minnie Pearl Nos. 1 and 2 claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Straight Creek claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Trachyte Nos. 1–20 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
V.C.A. claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Grand County—
General: 471.
Corvusite Nos. 1, 2, and 3 claims, on E slope of La Sal Mts.: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 1.12% U_3O_8: 440.
La Sal Mts. near Moab: 33; W slope: 104.
Mill Creek on Colorado (formerly Grand) River N of Moab: 404.
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Pack Creek, La Sal Mts.: 78; with tyuyamunite: 82.
Polar Mesa
Elva M. and adjoining claims: carnotite in saucer-shaped orebody, drilled by U.S.B.M., and showing from 0.05 to 0.24% U_3O_8 in the Elva M., Elva M. No. 2, and Mary No. 2 claims: 440.
Elva M. and Imp claims: 410.
Polar Nos. 2 and 3 claims: carnotite in irregular, well-defined rolls, drilled by U.S.B.M., and showing from 0.05 to 0.10% U_3O_8: 440.
Rim Rock and Rim Rock No. 2 claims: carnotite in large, thick, low grade orebody, drilled by U.S.B.M., and showing from less than 0.05 to 0.20% U_3O_8: 440.
Radium extraction: 476.
Richardson: 41, 78, 404, 410, 416, 464, 476, 511; with tyuyamunite: 82; on Colorado River: 34.
Thompsons area: 82, 511; 22 mi. SE of: 78.
Flat Top No. 1 claim: carnotite in rolls, drilling by U.S.B.M., and showing from 0.05 to 0.67% U_3O_8: 440.
Red Vanadium group: carnotite in rolls, drilled by U.S.B.M., and showing from 0.05 to 0.26% U_3O_8: 440.
Thompsons Springs, 10 mi. S of: 404.
Uvanco or Yellow Jacket mine: 410.
Juab County—
Thomas Range: in fluorite deposits in vein structures: 493; in uraniferous fluorite pipes: 504.
Kane County—
Bulloch claims near Orderville: autunite, torbernite, and uraniferous carbonized wood, disseminated or coating pebbles or fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
Pahreah: 511.
San Juan County—
Abajo Mts.: 404.
Big Indian Valley, N of Monticello: 78, 82.
Browns Hole area: 396.
Cane Springs Pass S of Moab: 34.
Bridger Jack flat: 437.
Cottonwood Canyon District—
Basin claim: ore horizon in sandstone drilled by U.S.B.M.: 440.
Big Hole mine, largest in district and owned by Blanding Mines Co.: carnotite in layers in sandstone, drilled by U.S.B.M.: 440.
Birthday, Shale, East Bank, Found No. 2, and Lost claims: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.

Blue Bird area, about 1½ mi. W of Cliffhouse claim and owned by V.C.A.: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Hangover Nos. 1 and 2 and Ridge Nos. 1 and 2 claims, on small tributary of Cottonwood Creek: carnotite in massive, thick lenticular, sandstone, drilled by U.S.B.M., and showing from zero to less than 0.05% U_3O_8: 440.
Dry Valley: in Morrison formation: 415.
Dry Valley, N of Monticello: 78, 82.
East Canyon: with tyuyamunite: 82.
Grey Dawn mine: with beta-uranotil, gummite, uraninite; lenticular pod-like structure, parallel to dip of Salt Wash sandstone beds: 480; structure, lenticular, irregular ore pods: 480; origin of ore, possibly alteration of hydrothermal ore deposits: 480.
La Sal Mountains: 396.
Lisbon (not Lisburne) Valley, N of Monticello: 78, 82.
Montezuma Canyon: 503.
Monument Valley: 63, 427.
Navajo Indian Reservation: 161.
White Canyon District—
White Canyon: 63; 8 mi. from Hite: 78.
Happy Jack mine: carnotite in thin seam, drilled by U.S.B.M., and showing no U_3O_8 so work was to be abandoned: 440.
Yellow Circle Group—
White Fawn and Yellow Circle claims: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from zero to 5.20% U_3O_8: 440.
Uintah County—
Vernal on Ashley's Fork: 464.
Washington County—
Silver Reef Mining District—
Silver Reef: a little above the water table in White and Buckeye "reefs" (sandstone beds): 415; in copper-uranium-vanadium deposit in irregular lenses of sandstone with clay pellets, a part of Chinle formation of Triassic age: 509; in mines on reef: 464; with autunite: 82.
Washington: 464.
Wayne County—
Capitol Reef Monument—
Capitol Reef: 63; region: 428.
Hanksville, 10 mi. N of: 404.
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Concentration process: 418.
Mesh test: 418.
Preliminary treatment: 418.
Radium test: 418.
Uranium concentration processes: 470.
Utah specimens: 418.
Value of process: 418.
Extraction Processes—
Chemical treatment: radium extraction from Colorado ore: 476; radium extraction from Utah ore: 476.
Radium extraction processes: 472.
Uranium extraction processes: 472.
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Acid method: 419.
Advantages in treating concentrates: 419.
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Results on Colorado ores: 419.
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La Plata County—
Durango: V.C.A. plant to treat carnotite ore from Navajo Indian Reservation: 140.
Mesa County—
Climax Uranium Co. mill, Grand Junction: acid-leaching process mill: 533, 534.
Montrose County—
General: carnotite ore formerly processed in mills at Denver or in the East: 407.
Standard Chemical Co.: formerly operated 50-ton mill on Lower San Miguel River for treating carnotite ore: 407.
Uravan: expansion at U. S. Vanadium Corp. mill; process for treating high-lime ores described: 557.

Colorado Plateau
General: carnotite ore formerly processed in mills at Denver or in the East: 407.
Colorado: Standard Chemical Co. formerly operated 50-ton mill on Lower San Miguel River for treating carnotite ore: 407.

United States
General—
Navajo Indian Reservation ore: to be treated at Durango, Colorado, plant, rehabilitated by V.C.A.: 140; to be treated at White Canyon District, Utah, pilot treatment plant: 140.

Utah
San Juan County—
Monticello:
Qualified uranium mill: owned by U.S.A.E.C. and operated by the Galigher Co. treats 100 t. carnotite per day: 461; leaching process: 408; treatment methods and equipment described: 461; treats four types of uranium ores, rejects from the sampling plant: low vanadium-low lime, high vanadium-low lime, low vanadium-high lime, high vanadium-high lime: 461; original processing plant operated by V.C.A. during World War II for production of uranium and vanadium: 461.
Uranium ore sampling plant: owned by U.S.A.E.C. and operated by A.S. & R. Co. acting as its sampling and ore buying agents: 461.
White Canyon District: pilot treatment plant: 140, 538; pilot plant to treat ore from Navajo Indian Reservation: 140.

CARNOTITE PRODUCTION

Colorado
General: 1949 production from 250 operations, of which 80% were in Colorado: 457.
Mesa-Montrose-San Miguel Cos.—
Uravan mineral belt: 565,000 t. carnotite ore produced from 1936–1943 or 78% of entire production from Colorado and Utah main producing region: 417.
Southwest Part—
General: radium, vanadium, uranium produced in 1919 valued at over five and one-half million: 407; total carnotite ore production, including 1919 approximately 29,000 t. averaging 1.90% U_3O_8 and 5.80% V_2O_5: 407.
Radium Co. of Colorado: formerly produced 10% carnotite ore: 407.
Radium Luminous Materials Corp.: formerly produced 8% of carnotite ore: 407.
Standard Chemical Co.: formerly largest operator in area; produced 75% of carnotite ore: 407.

Colorado Plateau
General: 1949 production from 250 operations, of which 80% were in Colorado: 457.
Colorado—
Southwest Part—
General: total production, including 1919, approximately 29,000 t. carnotite ore with 1.9% U_3O_8 and 5.8% V_2O_5: 407.

United States
General—
Carnotite: ores and concentrates shipped from U.S. mines from 1932–1941: 457.

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Mineralogical Studies—
Base-exchange determination: Calamity Mesa samples: 500.
Chemical analyses: Calamity Mesa samples: 500.
Differential thermal analysis: Calamity Mesa samples: 500.
Electron microscope study: Calamity Mesa samples: 500.
Petrographic microscope study: Calamity Mesa samples: 500.
X-ray powder patterns: Calamity Mesa samples: 500.
Montrose County—
Mineralogical Studies—
Base-exchange determination: Bitter Creek samples: 500.
Chemical analyses: Bitter Creek samples: 500.
Differential thermal analysis: Bitter Creek samples: 500.
Electron microscope study: Bitter Creek samples: 500.
Petrographic microscope study: Bitter Creek samples: 500.
X-ray powder patterns: Bitter Creek samples: 500.

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Colorado
Jefferson County—
Colorado Front Range—
Denver, 12 mi. from, in center of S. 28, R. 70 W., T. 2 S., Sixth Principal Meridian: carnotite in Laramie coal formation: 505.

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Utah
Emery County—
San Rafael Swell—
Green Vein group: 21.
Pay Day claim: 21.
Garfield County—
Escalante-Circle Cliffs area—
Circle Cliffs: 509.
Blue Jay claim: 21.
Falling Star claims: 21.
Oak Creek prospect 17 mi. NE of Boulder: 509.
Spotted Dog claim: 509.
San Juan County—
White Canyon District—
White Canyon: uranium and copper minerals in Shinarump Conglomerate as disseminated deposits in sandstones and as veins along fractures, sometimes as replacements in logs; similar deposits of lower grade in Chinle formation and in Moenkopi formation: 401; geology: 401; grade: 401; localization of deposits by uranium ore guides: 401: chemical controls: 401, general geologic controls: 401, relation to channel fills: 401, structural controls: 401; mineralogy: 401; origin: 401; production: 401; structure: 401.
Ace of Hearts claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bankrupt claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bear claim: copper-uranium deposit with 0.05–0.1% U: 401.
Bell claim: copper-uranium deposit with 0.1–0.3% U: 401.
Bridges claim: copper-uranium deposit with 0.01–0.05% U: 401.
Butler's claim: copper-uranium deposit with 0.05–0.1% U: 401.
Cub claim: copper-uranium deposit with 0.05–0.1% U: 401.
Dead Buck claim: copper-uranium deposit with 0.05–0.1% U: 401.
Found claim: copper-uranium deposit with 0.1–0.3% U: 401.
Four Aces claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey Canyon No. 4 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Frey claim: copper-uranium deposit with 0.05–0.1% U: 401.

Frey No. 1 claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey No. 2 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Gonaway-North Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Happy Jack mine: copper-uranium deposit with more than 0.3% U: 401.
Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Hideout No. 1 mine: in Shinarump conglomerate: 490.
Jacobs Chair claim: copper-uranium deposit with 0.05–0.1% U: 401.
Jerry claim: copper-uranium deposit with 0.05–0.1% U: 401.
Markie claim; copper-uranium deposit with 0.05–0.1% U: 401.
Mossback claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback (Old Jackpot) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Notch claim: copper-uranium deposit with 0.01–0.05% U: 401.
Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Posey mine: copper-uranium deposit with more than 0.3% U: 401.
Red Canyon No. 1 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Saddle claim: copper-uranium deposit with 0.01–0.05% U: 401.
Scenic No. 2 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Scenic No. 4 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scotty claim: copper-uranium deposit with 0.01–0.05% U: 401.
Standard claim: copper-uranium deposit with less than 0.01% U: 401.
Sunrise claim: copper-uranium deposit with 0.01–0.05% U: 401.
Unknown claim: copper-uranium deposit with less than 0.01% U: 401.
Uracop claim: copper-uranium deposit with 0.01–0.05% U: 401.
W.G.J.N.W. claim: copper-uranium deposit with less than 0.01% U: 401.
W.N. claim: copper-uranium deposit with 0.01–0.05% U: 401.
White Canyon No. 1 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Woodenshoe (?) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Yellow John claim: copper-uranium deposit with more than 0.3% U: 401.
Zebra claim: copper-uranium deposit with less than 0.01% U: 401.
White Canyon-Red Canyon District: 20.
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Washington County—
Silver Reef Mining District: 20, 478.
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Wayne County—
Capitol Reef Monument—
Oyler mine: 509; (called here: Oiler Tunnel, Blue Bird claims): 21.
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Diamond Drilling: 18, 154, 413, 501.
Methods and Results, 18, 154, 413, 501.
Utah: 18, 154.
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E

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Colorado
Chaffee County—
Clora May mine: in pegmatite with allanite: 234.
Crystal No. 8 mine: in pegmatite with allanite: 234.
Trout Creek Pass: in pegmatite: 70; analysis: 68.
Yard mine: in pegmatite with monazite: 234.

F

FLUORITE, URANIUM-BEARING

Colorado
General: 95.
Boulder County—
Jamestown: uraniferous fluorite breccia zones with pitchblende, uraninite, autunite, torbernite in fluorite-sulfide deposit: 504.
Blue Jay mine: uranothorite in fluorite breccias: 474, 475.
Burlington mine: uraniferous fluorite breccia zones worked to depths of 600 ft.: 504.
Nations Treasure mine: torbernite on fractures in fluorite in fluorite-sulfide deposit: 504.
El Paso County:
St. Peters Dome: kasolite in fluorite-quartz-sulfide deposits: 504.

Utah
General: 95.
Beaver County—
Indian Creek: autunite in fluorite-quartz-sulfide deposits: 504.
Staats mine: autunite, uranophane in fluorite: 504.
Juab County—
Honeycomb Hills: uranium minerals as coatings on fluorite in fluorite-quartz-sulfide deposits: 504.
Thomas Range: uraniferous fluorite pipes with carnotite: 504.
Bell Hill group of claims owned by Donald, Delbert, and T. E. Searle and Harold Ruthiford and leased to G. P. Spor: fluorite sample contained 0.4% uranium: 488.
Fluorine Queen property: irregular uraniferous fluorite pipe with carnotite: 504.
Fluorite (Original Spor) Group owned by G. P. Spor: less radioactive than Bell

FLUORITE, URANIUM-BEARING (contd.)
Hill and Harrisite groups but composite chip sample assayed 0.016% eU: 488.
Harrisite claims owned by E. D. and E. T. Harris: fluorite sample contained 0.25% uranium: 488.
Thursday property: uraniferous fluorite veins: 504.
Piute County—
Farmer John claims: uranium mineralization with fluorite; leased by Bullion Monarch Mining Co. for fluorite mining and, later, for uranium development: 522.

G

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GEOCHEMICAL RESEARCH
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General
Results of operations: 494.
Value as an exploration method: 494.
Instrumentation—
Geiger-type detectors: 494.
Scintillometers: 494.
Basic requirements of instruments used: Discriminator circuit to eliminate soft gamma-rays minimize effect of altitude variation: 494; Page recorder for permanent records: 494; Power supply adapted to 12 volt aircraft system: 494; Provision for marking page record to coordinate with position over ground: 494; Provision for suppression of background radiation by crystals or anticoincidence circuitry: 494; Several scales of sensitivity ranging downward from one milliroentgen/hr.: 494; Time constant at least as low as ½ second: 494; Total equipment weight not over 250 lbs: 494.
Operational Techniques—
Fixed-wing or helicopter-type aircraft: 494.
Grid flying or rim-flying: 494.
Locating Recorded Anomalous Radioactivity on Base Maps and Aerial Photographs—
Flying precise flight lines at fixed speed: 494.
Ground triangulation: 494.
Use of continuous strip recorder camera: 494.
Visual coordination using aerial photographs: 494.
Colorado
Montrose County—
Club Mesa: first low-altitude operation; done by Texas Co. in 1950: 494.
Long Park: first low-altitude operation; done by Texas Co. in 1950: 494.
Colorado Plateau
General—
Instrumentation: 494.
Operational Techniques: 494.
Results of operations: rim flying best in this area: 494.
Specific operations: airborne survey done in this area in Arizona, Colorado, New Mexico, and Utah: 494; airborne surveys for Hines Uranium Co.; no details available: 494; Anaconda Mining Co. cooperating with Rigg Aviation Service in Red Canyon district, Utah, 1951: 494; Excalibur Uranium Corp. in Green River desert, near Moab, and Cataract Canyon, Utah, in 1951: 494; first low-altitude operations, Texas Co. flights over Blanding, Utah, and Long Park and Club Mesa, Colorado, in 1950: 494; J. R. Simplot Co. in Henry Mts. and adjacent Green River desert country, Utah, in 1951: 494; Lundberg Explorations, Ltd., of Canada airborne survey for U.S.A.E.C. of Lukachukai Carrizo district, Arizona, 1951: 494; U.S.A.E.C. airborne reconnaissance of Grants area, New Mexico, in 1951: 494; U.S.A.E.C. airborne survey in Monument Valley, Arizona, in 1951: 494; U.S.A.E.C. experimental flying in Carrizo Mountain district, Arizona, in 1951: 494; U.S.G.S., limited airborne operations throughout the area: 494.
Value as an exploration method: only useful where deposits outcrop at surface: 494.
Colorado—
Club Mesa, Montrose Co.: first low-altitude operation; done by Texas Co. in 1950: 494.
Long Park, Montrose Co.: first low-altitude operation; done by Texas Co. in 1950: 494.
Utah—
Blanding, San Juan County: first low-altitude operation; done by Texas Co. in 1950: 494.

Cataract Canyon, San Juan County: airborne survey by Excalibur Uranium Corp.: 494.
Green River desert near Moab, Grand County: airborne survey by Excalibur Uranium Corp.: 494.
Henry Mts. and adjacent Green River desert, Garfield Co.: airborne survey by J. R. Simplot Co. in 1951: 494.
Red Canyon district, San Juan County: airborne survey by Anaconda Mining Co. cooperating with Rigg Aviation Service in 1951: 494.

Utah
Garfield County—
Green River desert adjacent to Henry Mts.: airborne survey by J. R. Simplot in 1951: 494.
Henry Mts.: airborne survey by J. R. Simplot Co. in 1951: 494.
Grand County—
Green River desert near Moab: airborne survey by Excalibur Uranium Corp. in 1951: 494.
San Juan County—
Blanding: first low-altitude operation; done by Texas Co. in 1950: 494.
Cataract Canyon: airborne survey by Excalibur Uranium Corp. in 1951: 494.
Red Canyon district: airborne survey by Anaconda Mining Co. cooperating with Rigg Aviation Service, in 1951: 494.

GEOPHYSICAL EXPLORATION (GROUND)

Colorado
Boulder County—
Caribou mine: Geiger-Mueller counter survey: 484.
Montrose County—
Bull Canyon: Potential Drop Ratio method: 498; Resistivity depth measurements method: 498.

GEOPHYSICAL RESEARCH

General
Geophysical Exploration—
Airborne methods: 494.
Ground methods: 498.
Methods: 494, 498.
See also: Geophysical Exploration.

GUMMITE OCCURRENCES

Colorado
Larimer County—
Crystal Mountain District 18 mi. SW of Fort Collins: in Big Boulder pegmatite with uranium minerals: 234; in Double Opening pegmatite with uranium minerals: 234.
Big Boulder prospect: in Big Boulder pegmatite with autunite: 234.
Double Opening prospect: in Double Opening pegmatite with autunite, torbernite, uraninite: 234.

Utah
San Juan County—
Grey Dawn mine: three pod-like occurrences with beta-uranotil, carnotite, uraninite: 480.

H-J

JOHANNITE OCCURRENCES

Colorado
Gilpin County—
Central City: 493.

Utah
San Juan County—
White Canyon: 401.
Happy Jack mine: with chalcanthite at surface: 493.

K

KASOLITE OCCURRENCES

Colorado
El Paso County—
St. Peters Dome: in fluorite-quartz-sulfide deposit: 504.

L

LAND WITHDRAWALS

Colorado
Public Land Order 459: land at New Mexico Principal Meridian withdrawn for U.S.A.E.C. use: 90.
Public Land Order 494: land at New Mexico Principal Meridian withdrawn for U.S.A.E.C. use: 90.
Public Land Order 565: land at New Mexico Principal Meridian withdrawn for U.S.A.E.C. use: 90.
Public Land Order 698: land at New Mexico Principal Meridian withdrawn for U.S.A.E.C. use: 90.
Montrose County—
Public Land Order 779: land withdrawn for U.S.A.E.C. use in uranium exploration: 555.

United States
General—
Colorado: 90; land withdrawn in Montrose County for U.S.A.E.C. use: 555.
Utah: 90; 66 sq. mi. of land in Grand County withdrawn for U.S.A.E.C. use: 542.

Utah
General—
Public Land Order 494: land at Salt Lake Meridian withdrawn for U.S.A.E.C. use: 90.
Public Land Order 565: land at Salt Lake Meridian withdrawn for U.S.A.E.C. use: 90.
Grand County—
Public Land Order 745: 66 sq. mi. withdrawn for U.S.A.E.C. use: 542.

LIGNITES, URANIUM-BEARING

See also under Uranium Occurrences—Types: 62.

Colorado
Jefferson County—
Golden, N. of: carnotite: 53.

LIMESTONES, URANIUM-BEARING

Colorado
Jefferson County—
Leyden coal mine: uranium minerals in limestone of Laramie formation of Cretaceous age: 509.

Utah
General: 27.
Northeast Part: uranium, possibly of syngenetic origin, in Uintah formation: 426.

M

MAPS

Uranium Occurrences
Location and Types of Uranium Deposits—
Colorado: 426, 443, 455, 486, 493, 504, 509.
Colorado Plateau: 443, 455, 486, 493, 509.
United States: 426, 443, 455, 486, 493, 504, 509.
Utah: 426, 443, 455, 486, 493, 504, 509.

META-TORBERNITE OCCURRENCES

Utah
Beaver County—
Newton Mining District—
Sniffer and Mystery claims: questionable occurrence with autunite (?) in argillized, silicified earlier Tertiary Bullion Canyon latite: 510.
Piute County—
Marysvale area—
Bullion Monarch mine: with pitchblende, autunite, schroeckingerite, torbernite, uranophane: 495.
East Slope No. 2 deposit: with autunite, schroeckingerite, uranophane along face of open cut coating fractures and joints in hornfels: 493.

MICROLITE OCCURRENCES

Colorado
Gunnison County—
Bazooka spodumene prospect: in pegmatite: 234.
Brown Derby: with betafite in pegmatite: 70.
Brown Derby mine: in pegmatite with monazite; chemical analysis shows U but no Th: 234.
Brown Derby No. 5 prospect: in pegmatite: 234.
Opportunity No. 1 prospect: in pegmatite: 234.
White Spar No. 1 prospect: in pegmatite: 234.

MINERALOGICAL STUDIES

Colorado
Mesa County—
Clays—
Base exchange determination: Calamity Mesa samples: 500.
Chemical analyses: Calamity Mesa samples: 500.
Differential thermal analysis: Calamity Mesa samples: 500.
Electron microscope study: Calamity Mesa samples: 500.
Petrographic microscope study: Calamity Mesa samples: 500.
X-ray powder patterns: Calamity Mesa samples: 500.
Montrose County—
Clays—
Base exchange determination: Bitter Creek samples: 500.
Chemical analyses: Bitter Creek samples: 500.
Differential thermal analysis: Bitter Creek samples: 500.
Electron microscope study: Bitter Creek samples: 500.
Petrographic microscope study: Bitter Creek samples: 500.
X-ray powder patterns: Bitter Creek samples: 500.

MONAZITE OCCURRENCES

Colorado
See Thorium Occurrences—Colorado: 11, 78, 82, 234, 252, 403, 457, 502.

Utah
See Thorium Occurrences—Utah: 11.

MONAZITE PRODUCTION

Colorado
General: small amounts: 457.
Climax Molybdenum Co. mill: monazite as by-product: 537.

MORRISON FORMATION

Carnotite Occurrences
General—
Colorado: 22.
Colorado Plateau: 22; channel deposits: 22; geology: 22; ore deposits: 22; origin: 22; uranium production: 22.
Utah: 22.

N-O

OPAL, URANIUM-BEARING

Utah
Piute County—
Marysvale area—
J. and L. alunite mine: in adit; material similar to opal but unusual green fluorescence like that of some hyalite: 451.
Trinity mine: in old workings; has brilliant green fluorescence: 451.

ORE GUIDES

See Uranium Ore Guides; Uranium Exploration.

ORIGIN

Carnotite Occurrences
Colorado—
General: 13, 22: probably syngenetic in Morrison and Entrada formations: 415; probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Colorado Plateau—
General: 13, 22, 407; probably syngenetic in Morrison and Entrada formations and

Shinarump conglomerate: 415; probably from ground-water solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
United States—
Sedimentary deposits of carnotite: 459.
Utah—
General: 13, 22; probably syngenetic in Shinarump conglomerate at Silver Reef: 415; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431; Grey Dawn mine: possibly, alteration of hydrothermal ore deposits: 480.

Copper-Uranium Deposits
Utah—
White Canyon: 401.
Happy Jack mine: 412.

Uranium Occurrences
Colorado—
Carnotite: 13, 22; probably syngenetic in Morrison and Entrada formations: 415; probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Hydrothermal solutions, precipitation from: Black King prospect: 449.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Colorado Plateau—
Carnotite: 13, 22, 407; probably syngenetic in Morrison and Entrada formations and Shinarump conglomerate: 415; probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
United States—
Sedimentary deposits of carnotite: 459.
Sedimentary uranium deposits: 34.
Utah—
Carnotite: 13, 22; probably syngenetic in Shinarump conglomerate at Silver Reef: 415; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Copper-uranium deposits:
White Canyon, 401.
Happy Jack mine: 412.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Uranium deposits at Marysvale: 451.

Uranothorite Occurrences
Colorado—
Hydrothermal solutions: precipitation from: Black King prospect: 474, 475.

P

PHOSPHATES, URANIUM-BEARING

General
Low grade uranium ores: Utah: 306.
Utah: low grade uranium ores: 306.

PHOSPHURANYLITE OCCURRENCES

Utah
San Juan County—
White Canyon: 401.

PITCHBLENDE MINERALOGY

General
Micrograph Examination—
Caribou mine, Colorado, specimen: 484.
Microscopic Examination—
Caribou mine, Colorado, specimen: 484.
Colorado specimens: 398.
Mineralization—
Colorado specimens: 398.
Paragenesis—
Colorado specimens: 398.
Colorado Plateau: deposits in asphaltite may involve polymerization by alpha particles of light hydrocarbons: 485; deposits in sedimentary rocks probably were formed contemporaneous with or shortly before associated copper sulfides: 485.
Radiographic Examination—
Caribou mine, Colorado, specimen: 484.
Study of Polished Section—
Caribou mine, Colorado, specimen: 484.

PITCHBLENDE OCCURRENCES

General
Depth of Deposits—
Vertical Range (200–400 feet): near surface or at depths: Colorado deposits from surface to as deep as 1000 ft.: 455.
Geology: 102.
Mineralization: 102.
Types of Deposits—
General: 102.

PITCHBLENDE OCCURRENCES (contd.)
Disseminations in sedimentary rocks: White Canyon, Utah: 455.
Vein deposit types: fluorite-quartz-sulfide type: 455; quartz-sulfide-type: 455; quartz-sulfide-carbonate type: 455; quartz-sulfide-carbonate-hematite type: 455.
Vein deposits in igneous rocks: Front Range mineral belt, Colorado: 455; Marysvale, Utah: 455.
Vein deposits in sedimentary or metamorphic rocks: San Miguel County, Colorado: 455.

Colorado
General: analysis of specimen: 472.
Colorado Front Range: 496.
Boulder County—
Front Range Mineral Belt—
Grand Island Mining District—
Caribou mine: 53, 102; in silver fissure veins in shear zones in quartz-monzonite stock: 484; in veins of the quartz-sulfide-carbonate type, with a little cobalt and some hematite-stained veins: 455; Geiger Mueller survey: 484; geology: 484; mineralization: 484; mineralogical examinations: 484; mineralogy: 484; ore zones vary from a few inches to 15 ft. in width and include silver, lead, zinc, and iron minerals with pitchblende: 484; results of Geiger-Mueller counter studies showed no radioactivity on the surface despite presence of pitchblende at the 1040 ft. level and its corresponding radioactivity: 484.
Caribou vein: analyses of samples from 1040 ft. level showed more pitchblende in parts rich in copper, lead, and silver than in those rich in zinc: 455.
Radium vein: in form of sooty black powder or solid lenticular masses with uranium content from 0.001 to 1.45% U_3O_8: 453; occurs as both the soft, sooty type formed later at lower temperatures and the hard botryoidal type formed earlier at higher temperatures: 468; ore in tension fracture of interconnecting vein system at vertical depths between 187 and 1075 ft.: 468; ore mineralization includes silver, lead, and zinc minerals but no nickel or cobalt: 468.
Jamestown: in veins of the fluorite-sulfide-quartz type occasionally with torbernite: 455; uraniferous fluorite breccia zones with uraninite, autunite, torbernite in fluorite-sulfide deposit: 504.
Clear Creek County—
Idaho Springs area—
Lawson-Dumont Mining District—
Bellevue Hudson mine, near Empire and Lawson: 517.
Golconda mine: in No. 4 vein, assaying 0.183% U_3O_8; also secondary uranium mineralization on Golconda tunnel walls: 487.
Jo Reynolds area: in a lead-zinc-silver ore body: 432.
Jo Reynolds mine near Lawson: 78, 82; in lead-zinc-silver deposit: 432; in vein deposits with gold and silver ore: 398; 8 t. high grade ore shipped from mine in 1919; sold in France for $80,000: 432; main deposits in vein in Elida tunnel: 432.
Lawson: in veins of the quartz-sulfide-carbonate type: secondary uranium minerals not in same vein: 455.
Lincoln Mining District—
Almaden mine: in small veinlet in Blazing Star vein and assaying 0.90% U_3O_8: 487.
Colorado Front Range—
General: in more than 20 vein deposits: 455.
Front Range Mineral Belt: distribution related to pattern of hypogene zoning: 458; distribution of deposits apparently restricted to an intermediate or transitional zone between central areas of pyritic gold veins and peripheral areas of silver-lead-zinc veins: 458; no indication as to whether pitchblende is more common in inner or outer part of intermediate zone: 458; significance of some geologic factors can be evaluated: 458; zonal distribution of pitchblende deposits influenced by at least seven geologic factors:
bostonite intrusives: 458; correlation of pitchblende with copper sulfides (and sulfo-salts?): 458; differences between paragenetic sequence and position of minerals in successive zones: 458; effective depth of mineralization: 458; fault patterns: 458; multiple stages of uranium mineralization: 458; scale and complexity of zoning in plan and in section: 458.
zonal distribution: 458.
Boulder County—
Caribou mine: 102, 453, 455, 458, 468, 484.
Gilpin County
Quartz Hill: in many mines (see Gilpin County entry below).
Gilpin County—
Front Range Mineral Belt—
Central City Mining District—
Quartz Hill: 511; in seven mines (not named): 399; mined in commercial quantities from four gold- and silver-bearing pyrite-sphalerite-galena veins on the south side: 467; massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Alps mine: in vein deposits with gold and silver ore: 398, 460.
Belcher mine: 78, 82, 330; in vein deposits with gold and silver ore: 398, 460.
Calhoun mine: 78, 82, 397; in vein deposits with gold and silver ore: 398, 460.
East Calhoun mine owned by Realty Co. of Denver: 53; not found in mineable quantities although some was produced from 1897–1914: 467.
West Calhoun mine owned by Realty Co. of Denver: production believed small since only available figures show 240 lbs. with 37.5% U_3O_8 mined in 1912: 467.

German lode: 473.
German mine: 78, 82, 330; in vein deposits with gold and silver ore: 398, 460.
German-Belcher mine: 53.
Kirk mine: 53, 78, 82, 330, 473; in vein deposits with gold and silver ore: 398, 460; in veins found from surface through 400 ft. depth: 455.
Leavenworth mine: with gold and silver ore: 460.
Mitchell mine: in vein deposits with gold and silver ore: 398, 460.
Pewabic mine in Russell Gulch: in vein deposits with gold and silver ore: 398, 460.
Russell Gulch: analysis: 68.
Wood mine near head of Leavenworth Gulch: 53, 78, 82, 397, 473; analysis: 68; discovered in 1871: 455; in vein deposits with gold and silver ore: 398, 460; under lease to and operated by Realty Co. of Denver: assays of pitchblende ranged from .023 to 14.5% eU and from .008 to 14.27% U: 467; in vein deposits: 452.
Wood vein: assays of pitchblende ranged from .023 to 14.5% eU and from .008 to 14.27% U: 467.
Wood and Kirk mines: ore averages 0.2% U_3O_8: 394.
Wyandotte mine: with gold and silver ore: 460.
Jefferson County—
Ralston Creek: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Several mines (not named): 82.
Lake County—
Colorado Mineral Belt—
Leadville Mining District: 477.
St. Kevin Mining District: questionable occurrence, with torbernite: 477.
Larimer County—
Copper King mine, 45 mi. NW of Fort Collins: 53, 543.
Prairie Divide: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Montrose County—
Paradox Valley: 464.
Ouray County—
Colorado Mineral Belt—
Lower Uncompahgre Mining District: 477.
Red Mountain Mining District: 477.
Upper Uncompahgre Mining District: 477.
Park County—
Colorado Mineral Belt—
Alma Mining District: 477.
San Miguel County—
General: in vein deposits: 455.

Colorado Front Range
General: 53, 496; age determinations: published age of 60 million years for Laramide pitchblende of Colorado Front Range confirmed by study: 492.
Colorado—
General: in more than 20 vein deposits: 455.
Front Range Mineral Belt: distribution of deposits apparently restricted to an intermediate or transitional zone between central areas of pyritic gold veins and peripheral areas of silver-lead-zinc veins: 458; distribution related to pattern of hypogene zoning: 458; no indication as to whether pitchblende is more common in an inner or outer part of intermediate zone: 458; significance of some geologic factors can be evaluated: 458; zonal distribution of pitchblende deposits influenced by at least seven geologic factors:
bostonite instrusives: 458; correlation of pitchblende with copper sulfide (and sulfo-salts?): 458; differences between paragenetic sequence and position of minerals in successive zones: 458; effective depth of mineralization: 458; fault patterns: 458; multiple stages of uranium mineralization: 458; scale and complexity of zoning in plan and in section: 458.
Zonal Distribution: Front Range Mineral Belt: 458.
Boulder County—
Grand Island Mining District—
Caribou mine: 53, 102; Geiger-Mueller survey: 484; geology: 484; in silver fissure veins in shear zones in quartz-monzonite stock: 484; in veins of the quartz-sulfide carbonate type, with a little cobalt: 455; mineralization: 484; mineralogical examinations: 484; mineralogy: 484; ore zones vary from a few inches to 15 ft. in width and include silver, lead, zinc, and iron minerals with pitchblende: 484; results of Geiger-Mueller counter studies showed no radioactivity on the surface despite presence of pitchblende at the 1040 ft. level and its corresponding radioactivity: 484.
Gilpin County—
Wood and Kirk mines, Quartz Hill: ore with average grade of 0.2% U_3O_8: 394.

Colorado Mineral Belt
Central Part—
Alma Mining District: 477.
Leadville Mining District: 477.
St. Kevin Mining District: questionable occurrence, torbernite: 477.
Southwest Part—
Lower Uncompahgre Mining District: 477.
Red Mountain Mining District: 477.
Upper Uncompahgre Mining District: 477.

Colorado Plateau
General: in sedimentary rocks, usually in lower Chinle and Shinarump formations: 485; occur with sulfides of copper or in asphaltic bodies but, in both cases, associated with fossil plants or beds rich in organic debris: 485; usually replace cell walls of plants while copper sulfides fill cells: 485.
Paragenesis: deposits in asphaltite may involve polymerization by alpha particles of light hydrocarbons: 485; deposits in sedimentary rocks probably were formed contemporaneous with or shortly before associated copper sulfides: 485.

PITCHBLENDE OCCURENCES (cont.)
Utah
Emery County—
San Rafael Swell—
Temple Mountain: deposits as minute grains, 1–10 microns in diameter, in ribbon or ellipsoidlike aggregates in asphaltite: 485.
Garfield County—
Oak Creek prospect 17 mi. NE of Boulder: 21.
Grand County—
Seven Mile Canyon: deposits replacing wood and rimming quartz and limestone pebbles: 485.
Piute County—
Marysvale area: 102; in structurally controlled veins: 443; in veins of the fluorite-sulfide-quartz type: 455; in veins with secondary uranium minerals: 493; several deposits: 429.
Buddy mine: a little with autunite: 495.
Bullion Monarch mine: with autunite, meta-torbernite, schroeckingerite, torbernite, uranophane: 495.
Farmer John open pit, Bullion Monarch Mining Co.: with autunite: 479.
Freedom lease, V.C.A.: with autunite: 479.
Freedom No. 1 (Seegmiller) mine: trace with autunite, schroeckingerite, torbernite: 495.
Prospector lease, V.C.A.: with autunite: 479.
Prospector mine under lease by V.C.A.: with autunite, torbernite, uranophane, and a calcium-uranium-oxide mineral (analogue of fluorite): 495.
V.C.A. properties: 532.
San Juan County—
White Canyon District—
White Canyon: deposits in sedimentary rocks replacing cell walls of fossil plants while copper sulfides fill cells: 485; dissemination associated with copper sulfides and secondary uranium minerals in sandstone in Shinarump conglomerate: 455.
Happy Jack mine: 401, 412; in copper-uranium deposit in mine workings 75 ft. underground: 509; in interior of deposit: 493.
Hideout mine: 401.
Posey mine: 401.

PITCHBLENDE PROCESSES
General
Radium extraction processes: 472.
Uranium extraction processes: 472.

PITCHBLENDE PRODUCTION
Colorado
Clear Creek County—
Lawson-Dumont Mining District—
Jo Reynolds mine: 8 t. assaying 72% U_3O_8 produced in 1919: 432.
Gilpin County—
Central City Mining District—
Quartz Hill—
Calhoun vein in East Calhoun mine: in commercial quantities from gold- and silver-bearing vein: 467.
German-Belcher vein in German and Belcher mines: in commercial quantities from gold- and silver-bearing vein: 467.
Kirk vein in Kirk mine: in commercial quantities from gold- and silver-bearing vein: 467.
West Calhoun mine: only record of production in 1912: 467.
Wood vein in Wood mine: in commercial quantities from gold- and silver-bearing vein: 467.

PROSPECTING FOR URANIUM
See Uranium Exploration: 154.

PROSPECTORS' GUIDES
See also: Uranium Exploration.
Colorado
General—
Uranium: 90.
Utah
General—
Uranium: 90.

Q-R

RADIOACTIVE AREAS
Colorado
Custer County—
Haputa Ranch near Westcliffe: radioactive veins, possibly carrying thorium or rare earths: 53.
Eagle County—
Gilman area, Eagle mine: galena and sphalerite ores, sulphides: 45.
Unnamed location: granites: 45.

RADIOACTIVE FLUORITE
Utah
Tooele County—
Sheeprock Mountains: radioactive fluorite-quartz-sulfide deposits: 504.

RADIOACTIVE GALENA ORES
Colorado
Eagle County—
Gilman area, Eagle mine: 45.

RADIOACTIVE OCCURRENCES
Colorado
Clear Creek County—
Pennsylvania tunnel near Fall River: small amount of slightly radioactive light-yellow to blue-green precipitate, probably goslarite, on walls and in backs of workings: 487.
Spring Gulch, Small prospect tunnel on north fork of: gave Geiger-counter reading of over twice background but source of radioactivity not determined: 487.
Standard tunnel near Fall River: small amount of slightly radioactive light-yellow to blue-green precipitate, probably goslarite, on walls and in backs of workings: 487.
Gilpin County—
Central City Mining District—
Quartz Hill—
Ayres Leavenworth mine: general: 467.

Belcher mine: general: 467.
Calhoun mine: general: 467.
Eldorado mine: general: 467.
German mine: general: 467.
Gold Rock mine: general: 467.
Harsh mine: general: 467.
Iron mine: general: 467.
Kirk mine: general: 467.
Pyrenees mine: general: 467.
Taylor Leavenworth mine: general: 467.
Waterloo mine: general: 467.
West Russell mine: general: 467.
Wood mine: general: 467.

Utah
Garfield County—
Escalante-Circle Cliffs area—
Honeybell and Farewell claims, Silver Falls Creek: slight radioactivity: 21.
Horse Creek and Hatch claims, Horse Creek: slight radioactivity: 21.

RADIOACTIVITY

General
Detection—
Methods: electroscope: 2.
Geiger-Mueller Counter: description: 2; use: 2.
photographic: 2.

RADIUM OCCURRENCES

See Uranium Occurrences—
Colorado: 503, Utah: 503.

RADIUM PROCESSES

General
Extraction Processes—
Chemical treatment: extraction from carnotite from Colorado: 476; extraction from carnotite from Utah: 476.

RADIUM PRODUCTION

Colorado
General: carnotite, processed in Europe: 7; carnotite ores from Colorado and Utah, 202 g. radium, from 1913–1923: 415.

United States
General—
Carnotite: ores from Colorado and Utah, 202 g. radium, from 1913–1923: 415.
Colorado carnotite ores: processed in Europe: 7.
Utah carnotite ores: processed in Europe: 7.

Utah
General: carnotite, processed in Europe: 7; carnotite ores from Colorado and Utah, 202 g. radium, from 1913–1923: 415.

S

SAMARSKITE OCCURRENCES

Colorado
Chaffee County—
Salida, 20 mi. from: in pegmatite: 414.
Turret district: 539.
Gunnison County—
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: with monazite, rare earth minerals, in pegmatite dike: 502.
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San Juan County—
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Physical Properties—
Utah specimen: 490.

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Marysvale area: 267, 522; in veins with other secondary uranium minerals and pitchblende: 493.
Bullion-Monarch mine: with pitchblende, autunite, meta-torbernite, torbernite, uranophane: 495.
East Slope No. 2 deposit: with autunite, metatorbernite, uranophane along face of open cut coating fractures and joints in hornfels: 493.
Freedom No. 1 (Seegmiller) mine: with autunite, torbernite, trace of pitchblende: 495.
Freedom No. 2 mine: with autunite, torbernite, uranophane: 495.
Prospector mine: fluorescent mineral with properties characteristic of schroeckingerite in quartz monzonite uranium-bearing zones: 447.
San Juan County—
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Utah
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SEDIMENTS, URANIUM-BEARING

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San Juan County—
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General: 9.

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Boulder County—

Blue Jay mine, Jamestown: uranothorite in fluorite breccias: 474, 475.

Boulder: allanite: 82.

Chaffee County—

Buena Vista: monazite: 82; monazite, 20 lbs. per ton: 11; monazite in black sands: 78.

Clora May mine: pegmatites with allanite, euxenite: 234.

Crystal No. 8 mine: pegmatites with allanite, euxenite: 234.

Salida, 20 mi. from: samarskite in pegmatite: 414.

Trout Creek Pass: euxenite, analysis: 68; euxenite in pegmatite: 70.

Turret district: samarskite: 539.

Yard mine: pegmatites with euxenite, monazite: 234.

Clear Creek County—

Grover mine: pegmatites with monazite, beryl: 234.

Costilla County—

San Lina Valley: monazite, 30 lbs. per ton: 11.

San Luis Valley: monazite: 78, 82; monazite, trace: 11.

Douglas County—

Devils Head: allanite: 82.

Newlin (not Newlands) Gulch district 20 mi. S of Denver: monazite: 252.

Platte Canyon: monazite: 252.

Fremont County—

Mica Lode mine operated by Colorado Feldspar Co., located on a conical knob in south central part of Eight Mile Park: pegmatites with allanite, thorite, triplite: 234.

Rowe's South Prospect, Micanite Mining District, E. of Mac Gulch: pegmatites with monazite: 234.

School Section mine, operated by Colorado Feldspar Co., SW part of Eight Mile Park: pegmatites with thorite or triplite: 234.

Fremont-Park Counties—

Guffey-Micanite region: monazite, uranothorite (?) in granitic pegmatites: 403; petrology: 403.

Gilpin County—

Central City: monazite, trace: 11.

Russell Gulch: pitchblende, analysis: 68.

Wood mine, Central City Mining District: pitchblende, analysis: 68.

Gunnison County—

Bazooka spodumene prospect: pegmatite with microlite: 234.

Brown Derby: betafite, microlite in pegmatite: 70.

Brown Derby mine: pegmatite with microlite and monazite; chemical analysis of microlite, 1.69% UO_2, 2.40% UO_2, no Th: 234.

Brown Derby No. 5 prospect: pegmatite with microlite: 234.

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Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: samarskite, monazite, rare earth minerals, in pegmatite dike: 502.

Gold Creek near Gunnison: samarskite: 535; samarskite, radioactive minerals: 536.

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Centennial Cone beryl-monazite prospect: pegmatite with monazite: 234.

Roscoe beryl prospect: pegmatite with gadolinite and monazite previously reported but not found in 1943: 234.

Larimer County—

Copper King mine, 45 mi. NW of Fort Collins: pitchblende: 543.

Routt County—

Hahn's Peak: monazite, trace: 11.

Timber Lake: monazite: 78, 82; monazite, 416 and 520 lbs. per ton: 11.

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Salt Lake County—

Salt Lake City: monazite: 217.

Uintah County—

Green River, Jensen District: monazite: 78, 82; monazite, 2 to 25.4 lbs. per ton: 11.

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Black King No. 5 prospect near Placerville in S. 27, T. 44 N., R. 11 W., owned by Hugh D., H. B., and Guy E. Weatherly (formerly called Evans property): with uraninite: 469.
Black King prospect near Placerville: containing minute specks of uraninite: 449; mineralogical studies: 449.
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Nations Treasure mine: on fracture in fluorite in fluorite-sulfide deposit: 504.
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George Peabody claim: with unidentified radioactive mineral associated with hydrous iron oxide on fracture surfaces in pre-Cambrian granite and pegmatite: 454.
Fremont County—
Jesus lode: or autunite and uraniferous carbonized wood in Cretaceous Dakota sandstone: 509.
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Crystal Mountain District 18 mi. SW of Fort Collins: in Big Boulder pegmatite with uranium minerals: 234; in Double Opening pegmatite with uranium minerals: 234.
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Hyatt beryl mine: in pegmatite with autunite, uraninite: 234.
Colorado Mineral Belt
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Oak Creek prospect: with uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Spotted Dog claim: with carbonized uraniferous plant fragments in copper-uranium deposit: 509.
Kane County—
Bulloch claims near Orderville: with autunite, carnotite, and uraniferous carbonized wood, disseminated or coating pebbles or fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
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Piute County—
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Bullion-Monarch mine: with pitchblende, autunite, meta-torbernite, schroeckingerite, uranophane: 495.
Bullion-Monarch Mining Co. properties: 532.
Freedom No. 1 (Seegmiller) mine: with autunite, trace of pitchblende, schroeckingerite: 495.
Freedom No. 2 mine: with autunite, schroeckingerite, uranophane: 495.
Prospector mine under lease by V.C.A.: with pitchblende, a calcium-uranium oxide mineral (analogue of fluorite), autunite, uranophane: 495.
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Uinta Basin: with uraniferous carbonized plant fragments in copper-uranium deposit: 509.
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U.S. Vanadium Co.: leases most of its mining property to small operators for working: 431.
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Colorado Front Range: general (pitchblende, etc.): 496; reconnaissance work in 1949: 496.
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Jamestown: pitchblende in veins of the fluorite-sulfide-quartz type, occasionally with torbernite: 455; uraniferous fluorite breccia zones with pitchblende, uraninite, autunite, torbernite, in fluorite-sulfide deposit: 504.
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Nations Treasure mine: torbernite on fractures in fluorite in fluorite-sulfide deposit: 504.
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Trout Creek Pass: euxenite, analysis: 68; euxenite in pegmatite: 70.
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Lawson-Dumont Mining District—
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Golconda mine: pitchblende assaying 0.183% U_3O_8 and secondary uranium mineralization on tunnel walls in No. 4 vein: 487; geology: 487; radioactivity in other veins in mine: 487.
Jo Reynolds area: pitchblende in a lead-zinc-silver orebody: 432.
Jo Reynolds mine near Lawson: pitchblende: 78, 82; pitchblende in lead-zinc-silver deposit: 432; pitchblende in vein deposits with gold and silver ore: 398; pitchblende, 8 t. shipped from mine in 1919; sold in France for $80,000: 432; pitchblende, main deposits in vein in Elida tunnel: 432; economic geology: 432; geology: 432; structure: 432; structure and mineralization: 398; uranium: 53.
Lawson: pitchblende in veins of the quartz-sulfide-carbonate type; secondary uranium minerals not in same vein: 455.
Lawson-Dust deposits: uranium: 53.
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Lincoln Mining District—
Almaden mine: sample of oxidized siliceous pyritic rock from dump at Blazing Star vein assayed 2.4% U_3O_8: 487; siliceous oxidized zone 360 ft. from portal in Blazing Star vein assayed 0.14% U_3O_8: 487; geology: 487, pitchblende assaying 0.90% U_3O_8 in small veinlet in Blazing Star vein with secondary uranium minerals on pitchblende surface and vein walls: 487.
Seven Forty tunnel near Fall River: selected sample from dump assayed 0.008% U_3O_8 but tunnel is inaccessible: 487.
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St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also as coatings on fracture surfaces and disseminations in country rock; torbernite and sooty pitchblende present, probably alteration products of primary pitchblende: 477.
Ouray County—
General: pitchblende present, probably hypogene: 477.
Lower Uncompahgre Mining District: uranium with base and precious-metal veins: 477.
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Geology: 431.
Government operations: 431.
Historical development of mining program: 431.
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Mining methods and operations: 431.
Origin of deposits: 431.
Work of small scale operators: 431.
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Dove Creek, La Veta Pass, 22 mi. W. of Walsenburg: uranium: 411.

Radium Group of mines near Dove Creek, operated by Dulaney Mining Co.: uranium ore seams as thin as 1½ to 2 ft. and mined after removal of 15 ft. of barren overburden: 456.
Dolores County—
General: carnotite: 41; carnotite carrying 3–4% uranium oxide: 470.
Rio Dolores: carnotite: 78, 82.
Eagle County—
Brush Creek, 7 mi. SE of Eagle: carnotite: 34, 82; carnotite in sandstone: 78.
Horse Mountain: silver-copper-carnotite deposit: 46.
El Paso County—
Mike Doyle prospect: carnotite in Morrison sandstone as coating on fracture surfaces and on carbonized wood fragments: 402; geology: 402; structure: 402; three samples of carnotite showed respectively 0.09% U, 0.22% U_3O_8, and 0.27% U_3O_8: 402; uranium-bearing material in carbonaceous shale underlying the sandstone: 402; uranium deposits in Morrison formation controlled by fractures and related faults: 509.
St. Peters Dome: kasolite in fluorite-quartz-sulfide deposit: 504.
Fremont County—
Jesus lode: torbernite or autunite and uraniferous carbonized wood in Cretaceous Dakota sandstone: 509.
Fremont-Park Counties—
Guffey-Micanite region: monazite, uranothorite (?) in granitic pegmatites: 403; petrology: 403.
Garfield County—
General: carnotite: 82.
East Rifle Creek: carnotite: 34.
Rifle: carnotite: 459; carnotite and roscoelite in Entrada formation: 509.
Rifle mine of U.S. Vanadium Corp. (now Co.) on East Rifle Creek 12 mi. NE of Rifle: geology: 415; small amounts of carnotite in vanadium-bearing Entrada sandstone: 415.
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Front Range Mineral Belt—
Central City Mining District—
Central City: uraconite on mine faces: johannite: 493.
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Alps mine: pitchblende in vein deposits with gold and silver ore: 398, 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; structure and mineralization: 398.
Belcher mine: pitchblende: 78, 82; pitchblende in vein deposits with gold and silver ore; assays of uranium ores and concentrates given: 398; pitchblende with gold and silver ore: 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende, production: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7.
Black Hawk mine: uraninite: 104.
Calhoun mine: pitchblende: 78, 82, 397; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460; pitchblende in vein deposits with gold and silver ore; assays of uranium ore: 398; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7.
Calhoun properties: uranium ore found above water level and on dumps: 420.
East Calhoun mine owned by Realty Co. of Denver: pitchblende: 53.
Calhoun vein: geology: 467; mineralogy: 467; orebodies: 467; pitchblende in mineable quantities not known from this mine: 467; pitchblende produced from it from 1897–1914; no figures on amount: 467.
West Calhoun mine owned by Realty Co. of Denver: geology: 467; pitchblende production believed small since only available production figures show 240 lbs. with 37.5% U_3O_8 mined in 1912: 467.
Duponts' exploring small area: 420.
European syndicate working large area: 420.
German lode: pitchblende: 473.
German mine: pitchblende: 78, 82; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore; assays of uranium ores and concentrates given: 398; pitchblende with gold and silver ore: 460; pitchblende, porduction: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7.
German-Belcher mine: pitchblende: 53.
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Kirk mine: pitchblende: 53, 78, 82, 473; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore; assays of

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uranium ore: 398; pitchblende veins found from surface through 400 ft. depth: 455; pitchblende with gold and silver ore: 460; pitchblende, production: 330; mineralogy of deposit: 7; structure and mineralization: 398; uraninite: 7, 104.
Leavenworth mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore: 460.
Mitchell mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende in vein deposits with gold and silver ore: 398, 460; structure and mineralization: 398.
Pewabic mine in Russell Gulch: pitchblende in vein deposits with gold and silver ore: 398, 460; pitchblende contemporaneous with or earlier than pyritic veins: 460; structure and mineralization: 398; operations: 53.
Pyrenees mine: uraninite-bearing ore from dump; polished surface studied, showing rather abundant uraninite: 506.
Russell Gulch: pitchblende, analysis: 68.
Springdale mine: uraninite-bearing ore from dump; polished surface studied, showing rather abundant uraninite: 506.
Wood mine near head of Leavenworth Gulch: mineralization and structure: 398; mineralogy of deposit: 7; pitchblende: 53, 78, 82, 397, 473; pitchblende, analysis: 68; pitchblende in vein deposits with gold and silver ore; assays of uranium ore: 398; pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460; pitchblende discovered in 1871: 455; uraninite: 7, 104; under lease to and operated by Realty Co. of Denver: dump samples show wide discrepancy between radioactivity and uranium content with three samples showing ranges of 1.03–0.002% eU, 0.055–0.002% eU, and 0.005–0.001% eU: 452; geology: 452; high radioactivity on dump and in uppermost workings: 452; pitchblende in vein deposits: 452; reconnaissance investigations in 1950: 452.
Wood vein: assays of pitchblende samples ranged in uranium content from .023–14.5% eU and from .008 to 14.27% U: 467; geology: 467; history: pitchblende first discovered on dump there in 1871: 467; mineralogy: 467; orebodies: 467; production figures given for uranium ore produced from this mine: total about 102,600 t. ore with 30,040 lbs. U_3O_8: 467; suggestions for further exploration: 467.
Wyandotte mine: pitchblende contemporaneous with or earlier than pyritic veins: 460; pitchblende with gold and silver ore: 460.
Gunnison County—
Bazooka spodumene prospect: pegmatite with microlite: 234.
Brown Derby: betafite, microlite in pegmatite: 70.
Brown Derby mine: pegmatite with microlite and monazite; chemical analysis of microlite, 1.69% UO_2, 2.40% UO_3, no Th: 234.
Brown Derby No. 5 prospect: pegmatite with microlite: 234.
Gold Brick Mining District—
Beryllium Mining Co., Inc., operations on mountains bordering Willow Creek: samarskite, monazite, rare earth minerals in pegmatite dike: 502.
Gold Creek near Gunnison: samarskite: 535; samarskite, radioactive minerals: 536.
Opportunity No. 1 prospect: pegmatite with microlite: 234.
White Spar No. 1 prospect: pegmatite with microlite: 234.
Huerfano County—
McIntire prospect, Huerfano Park: carnotite, carbonized wood, and radioactive iron oxide as uranium-bearing materials in copper-uranium deposit in Triassic Shinarump conglomerate: 509.
Jefferson County—
Bigger mica mine: pegmatite with monazite, uraninite: 234.
Denver, 12 mi. from, in center of S. 28, R. 70 W., T.2 S., Sixth Principal Meridian: carnotite in Laramie coal formation; readily accessible for mining and shipping by railroad: 505.
Golden, N. of: carnotite in lignites: 53.
Golden Gate Canyon: uranium: 53.
Leyden coal mine: uranium minerals in limestone of Laramie formation of Cretaceous age: 509.
Ralston Creek: massive and sooty pitchblende in veins of quartz-sulfide type: 455; uranium: 53.
Several mines (not named): pitchblende: 82.
Lake County—
Colorado Mineral Belt—
Leadville Mining District: uranium as coatings on fracture surfaces or disseminations in country rock: 477.
St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also, as coatings on fracture surface and disseminations in country rock; torbernite and sooty pitchblende present, probably alteration products of primary pitchblende: 477.
Larimer County—
Buckhorn mine, 17 mi. SW of Fort Collins: uranium in pegmatite: 491.
Copper King mine, 45 mi. NW of Fort Collins: pitchblende: 53, 543.

Crystal Mountain District—
Crystal Mt. District 18 mi. SW of Fort Collins: Big Boulder pegmatite with uranium minerals: 234; Double Opening pegmatite with uranium minerals: 234.
Big Boulder prospect: Big Boulder pegmatite with autunite, gummite: 234.
Double Opening prospect: Double Opening pegmatite with autunite, gummite, torbernite, and uraninite: 234.
Hyatt: uraninite in beryl pegmatite: 70.
Hyatt beryl mine: pegmatite with autunite, torbernite, uraninite: 234.
Prairie Divide: massive and sooty pitchblende in veins of quartz-sulfide type: 455.
Treasure Hill area 20 mi. NW of Fort Collins: 15 samples tested with Geiger counter showed a range of 0.0000–0.003% eU and an average of 0.001% eU: 508; geology: 508.
Casey lease, leased from Mrs. Ruth Casey: one sample from dump pit showed 1.0 tested with counter at scale 0.2 and 0.000% eU: 508; geology: 508.
Treasure Hill Nos. 1–6 claims owned by Mrs. Mildred Davis and Orville and Clifford Woodhams: ten samples showed a range of 1.0–2.0 tested with counter at scale 0.2 and 0.000–0.002% eU: 508; geology: 508.
West Point claim owned by Mrs. Mildred Davis and Orville and Clifford Woodhams: four samples showed a range of 0.5–2.5 tested with counter at scale 0.2 and 0.0000–0.003% eU: 508; geology: 508.
Mesa County—
Arrowhead group, Calamity area: Minerals Engineering Co. operating mine: 413.
Calamity Creek: tyuyamunite: 438; uranium mineral: 434.
East Gateway area—
Calamity Group:
Calamity group, Calamity Mesa: carnotite deposits, drilled in U.S.G.S. drilling program, yielding geologic log for study and resulting formulation of geologic guides: 501.
Calamity Nos. 1 and 3 and Triangle claims: carnotite in fossil trees, irregular elongate rolls, and blanket bodies parallel to bedding of sediments of lower Morrison formation exposed on three sides, drilled by U.S.B.M., showing from none or less than 0.05 to 1.81% U_3O_8: 440.
Calamity Nos. 7, 8, 9, and 23, and Crackerjack claims: carnotite in elongate rolls and fossil trees, drilled by U.S.B.M., and showing from less than 0.05 to 1.04% U_3O_8; and one blanket type deposit: 440.
Calamity Nos. 13, 17, and 18 claims: carnotite and uranium-vanadium minerals in fossil logs, which when close together are connected by blanket-like layers of ore, drilled by U.S.B.M., and showing from less than 0.05 to 1.70% U_3O_8: 440.
Calamity Nos. 20, 27, and 3, and Dixie claims: carnotite in fossil logs, small rolls, and two zones in some cases, drilled by U.S.B.M., and showing from less than 0.05 to 1.57% U_3O_8 with no ore revealed in Dixie claim by drilling: 440.
Calamity Mesa, Uravan Mineral Belt: 411; analyses gave average uranium content of 0.0014% in gray clay and 0.0017% in red clay: 500; carnotite deposits in small patches of favorable ground: 417; mineralogical studies made on clays: 500; radiometric studies showed an average count of 0.0022% eU for gray clay and 0.0018% eU for red clay: 500; 21 samples of clays tested: 500; uranium in sandstone in Morrison formation underlain by red and gray clays at varying depths: 500.
Maverick Group:
Hidden Treasure claim: carnotite in crescent-shaped ore deposit, drilled by U.S.B.M., showing from less than 0.05 to 0.11% U_3O_8, mined from two zones 15 ft. apart: 440.
Hummer and Great Hesper claims: carnotite in small rolls in elongate, crescent-sahped cluster drilled by U.S.B.M., and showing from less than 0.05 to 0.63% U_3O_8: 440.
Gateway: 411.
Hummer mine worked by U. S. Vanadium Co.: carnotite; even fines collected: 456.
Outlaw Mesa area, Uravan Mineral Belt: carnotite deposits in several patches of favorable ground from one to several thousand feet wide and over a mile long: 417.
Climax Uranium Co. operations: 456.
Rio Dolores around Gateway area: carnotite in sandstone along river: 78, 82.
Mesa-Montrose-San Miguel Counties—
Uravan Mineral Belt: carnotite deposits in Morrison formation: 417; carnotite ore averages 0.25% U_3O_8 and 2% V_2O_5: 417; orebodies, irregular tabular layers, parallel to sandstone bedding, ranging in width from a few to several hundred feet, with an average thickness of 2–4 ft. and ore content of a few to several thousand tons: 417; origin, probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417.
Mineral County—
Blanco Basin to West Fork: uranium claims: 514.
Moffat County—
Blue Mountain: carnotite: 34.
Blue Mountain near Skull Creek: carnotite: 78, 82.
Blue Mountain 2 mi. W of Skull Creek: carnotite: 422.
Blue Mountain Mining District: carnotite: 241.
Skull Creek: carnotite: 511; carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils in shale and sandstone in upper part

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of Jurassic Navajo sandstone and in sandstones of Permian and Pennsylvanian Maroon formation: 509.
Skull Creek Mining District: carnotite: 241.
Montezuma County—
General: carnotite: 41; carnotite carrying 3–4% uranium oxide: 470.
Montrose County—
General: carnotite: 41, 471, 476; carnotite carrying 3–4% uranium oxide: 470.
Bitter Creek Group: Dynamite mine: analyses gave average uranium content of 0.0014% in gray clay and 0.0017% in red clay: 500; mineralogical studies made on clays: 500; radiometric studies showed an an average count of 0.0022% eU for gray clay and 0.0018% eU for red clay: 500; uranium in sandstone in Morrison formation underlain by red and gray clays with an irregular boundary between them: 500.
Bull Canyon: carnotite in Morrison formation: 415; geology: 498; geophysical exploration: 498; three or more operating uranium mines: 498.
Club Camp at Naturita: carnotite: 34; group of claims, carnotite in Morrison formation: 415.
Club Camp of the Standard Chemical Co. on W rim of San Miguel canyon 4 mi. above junction with Dolores River: carnotite deposits in McElmo formation: fully equipped camp: 407.
Club Mesa, Uravan Mineral Belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Cracker Jack claim, Calamity Gulch: carnotite: 34; carnotite in large petrified logs in Morrison formation: 415.
Dolores Camp: uranium minerals: 434.
Dolores Camp claims, N side of San Miguel River: carnotite: 34; carnotite in two large petrified logs in Morrison formation: 415.
Dolores Camp of Standard Chemical Co. on E rim of San Miguel canyon at junction of Dolores and San Miguel Rivers: carnotite deposits in McElmo formation did yield about 3 t. ore per day: 407.
Gypsum Valley District—
Gyp, Gyp No. 1, and Aztec mines: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing 0.25% U_3O_8 only in Gyp mine, with Gyp No. 1 and Aztec mines blank: 440.
Raven and adjoining claims: carnotite in rolls, land owned by V.C.A., drilled by U.S.B.M., and showing from less than 0.05 to 3.44% U_3O_8: 440.
Roosevelt mine: carnotite in thin layers, land owned by V.C.A., drilled by U.S.B.M., and showing less than 0.005% U_3O_8 in one drill hole, other was blank: 440.
Hydraulic Mining District: carnotite: 241.
La Sal Creek: carnotite: 439; carnotite in sandstone: 78, 82; carnotite, specimen analyzed: 472.
Yellow Boy claim: carnotite: 473.
La Sal Creek 6 mi. from Cashin: carnotite: 104.
La Sal Mining District: carnotite: 241.
La Sal Valley: carnotite: 459.
Mesa Creek: carnotite in Morrison formation: 415.
Naturita Mining District: carnotite: 241.
Paradox Valley: carnotite: 1, 7, 439, 459; carnotite, pitchblende: 464; tyuyamunite: 438; uranium production: 118.
Paradox Valley, E slope: uraninite: 104.
Cripple Creek claim, Long Park: carnotite: 34.
Hieroglyphic camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Jack Rabbit camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Jo Dandy camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; carnotite occurrences in McElmo formation worked under 140 ft. of cover in some cases: 407; mined earlier by General Vanadium Co. and declared exhausted: 407.
Jo Dandy claim: carnotite: 434.
Julian camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Long Park: carnotite mining carried out in open cuts, tunnels, and inclines: 407; carnotite ore production about 5 t. per day: 407; total shipping production of about 4200 t. carnotite ore averaging 2% U_3O_8 in McElmo formation: 407; camps of Radium Co. of Colorado and Radium Luminous Materials Corp: 407; Uravan Mineral Belt: carnotite deposits in patches of favorable ground in en echelon arrangement: 417.
Maggie C claim, Long Park: carnotite: 34.
Monogram camp owned and operated by Standard Chemical Co.: carnotite claims on faulted segment of carnotite strata: 407; carnotite in Morrison formation: 415; mining operations were carried on by hand: 407; three adits worked and several carnotite orebodies present: 407.
Outlaw camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Paradox Creek: carnotite in sandstone: 78, 82.
Saucer Basin camp between Long Park and San Miguel River: camp left idle after exhaustion of exposed carnotite orebodies: 407.
Shamrock group including Shamrock and Old Salt Lick claims, owned by U. S. Vanadium Co.: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from less than 0.05 to 1.43% U_3O_8: 440.
Roc Creek: carnotite: 439; carnotite in sandstone: 78, 82; uranium minerals: 416.
Copper Prince claim: carnotite: 473.
Roc Creek Mining District: carnotite: 241.

Sinbad Valley: carnotite: 435, 439, 459.
Uravan: carnotite deposits in Morrison formation: 417.
Vixen Mining District: carnotite: 241.
Ouray County—
Colorado Mineral Belt—
Lower Uncompahgre Mining District: uranium with base and precious-metal veins: 477.
Pitchblende deposits present, probably hypogene: 477.
Red Mountain Mining District: uranium with pyritic veins and copper-lead-silver volcanic breccia pipes: 477.
Red Mountain Mining District, San Juan area: uranium: 551.
Uncompahgre Canyon S of Ouray: uranium in black slate: 53.
Uncompahgre Canyon, San Juan area: uranium: 551.
Upper Uncomphagre Mining District: uranium as coatings on fracture surfaces or disseminations in country rock: 477.
Park County—
Colorado Mineral Belt—
Alma Mining District: uranium with base and precious-metal veins; pitchblende present: 477.
Fairplay area: carnotite in Upper Morrison formation: 53.
Garo: carnotite and volborthite associated with uraniferous carbonaceous shale and carbonized plant fossils, in shale and sandstone in upper part of Jurassic Navajo sandstone and in sandstone of Permian and Pennsylvanian Maroon formation: 509.
Hartsel, 8 mi. N of: uranium: 512.
See also under Fremont-Park Counties: 403.
Rio Blanco County—
Coal Creek: carnotite: 34, 422.
Coal Creek 14 mi. NE of Meeker: carnotite: 78, 82.
Caywood claims: carnotite: 423.
Coal Creek anticline: uranium in isolated orebodies on large anticlines and domes: 481.
Coal Creek Mining District: carnotite: 241.
J. Mackay mine No. 2: carnotite: 418; carnotite concentration process results: 418; carnotite mineralogy: 418.
Meeker: carnotite: 511; carnotite in Morrison formation: 509.
Routt County—
General: carnotite: 82.
San Miguel County—
General: carnotite: 41; pitchblende in vein deposits: 455.
Asphalts, Uranium-bearing-
Placerville: 34.
Black King prospect near Placerville: geology: 449; mineralization including copper, iron, and lead minerals and some chromian mica: 449; mineralogical studies of uraninite specimens: 445; origin, probably precipitation from hydrothermal solution: 449; roscoelite-type uranium-vanadium deposits in Entrada sandstone: origin: 449; thucholite containing minute specks of uraninite along a fault and a fissure: 449.
Black King No. 5 prospect near Placerville in S.27, T.44 N., R.11 W., owned by Hugh D., H .B., and Guy E. Weatherly (formerly called Evans property): chemical analyses: 469; geology: 469; mineralization: 469; radiometric analyses: 469; structure: 469; uraninite, thucholite ore of commercial grade: 469.
Cedar Mining District: carnotite: 241.
Disappointment Creek, at joining with Dolores River and 80 mi. W of Dolores: uraninite: 104.
Disappointment Creek near Cedar: carnotite: 78, 82.
Egnar-Slick Rock District—
Buckhorn and Cone claims: carnotite in rolls and a log, drilled by U.S.B.M., and showing from less than 0.05 to 1.74% U_3O_8: 440.
Hawk Nos. 1 and 2 and Frankie No. 1 claims: carnotite in rolls, drilled by U.S.B.M., and showing from none or less than 0.05 to 2.62% U_3O_8: 440.
Hogback and Marie claims in Bishop and Summit Canyons: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Radium-Sitton area W of Egnar: F.A. Sitton operation: 413.
Radium No. 2 and adjoining claims: carnotite in large orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 7.55% U_3O_8: 440.
Radium No. 4 claim: produced 325 t. ore with 1.75% V_2O_5 but U.S.B.M. drilling gave blank holes; ore in rolls: 440.
Radium No. 6 claim: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 7.00% U_3O_8: 440.
Slick Rock: geology: 431; history: 431; largest mine of group, Incline No. 1 mine, producing 300 t. uranium ore per month: 431; mechanized equipment used at Incline Nos. 3 and 4 mines: 431; mining methods: 431; mining problems: 431; production of 500 to 600 t. average grade uranium ore per month: 431; typical small uranium operation: 431.
Uncle Sam and Mucho Grande claims: carnotite in lenticular orebodies, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Charles T Group: Fraction No. 1 and Summit claims: carnotite in sandstone, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 2.13% U_3O_8: 440.
Legin Group: Minerals Engineering Co. operations: 413.
Frenchy, King, King No. 2, May, and Sam claims: carnotite in elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.92% U_3O_8: 440.
Lower Group: Cougar, Last Chance, Little Mariel, and Rainbow claims: carnotite in large elongate rolls, land owned by North Continent Mines, Inc., drilled by U.S.B.M., and showing from less than 0.05 to 1.80% U_3O_8: 440.

URANIUM OCCURRENCES (contd.)
Gypsum Valley District—
Gypsum Valley: carnotite: 416.
Gypsum Valley, Disappointment District: carnotite: 439.
Jack Knife claim: carnotite in a roll, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Lost claim: carnotite in thin layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.25% U_3O_8: 440.
Main Street claim: carnotite in layers and small rolls, drilled by U.S.B.M., and showing less than 0.05% U_3O_8 in one hole and blanks in two others: 440.
Pay Day claim: carnotite in two blanket-like layers of ore, drilled by U.S.B.M. and showing less than 0.05% U_3O_8: 440.
Pitchfork claim: carnotite in layers, drilled by U.S.B.M., and showing from less than 0.05 to 0.10% U_3O_8: 440.
Riverview claim: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.33% U_3O_8: 440.
McIntyre District: carnotite in Morrison formation: 415.
Placerville: carnotite: 78, 82, 435, 439; carnotite, roscoelite: 459; carnotite, roscoelite in Entrada formation: 509; uranium with asphalt: 34.
Snyderville Mining District: carnotite: 241.
White Spar prospect, 2000 ft. E of Placerville post office, in S.35, T.44 N., R.11 W., owned by Boyd Robinson: chemical analyses: 469; geology: 469; radiometric analyses: 469; thucholite, uraninite ore of commercial grade: 469.
Southwest Part—
Dulaney property: produces 60% of U.S. uranium: 518.
Colorado Front Range
General: 267; age determinations: published age of 60 million years for Laramide pitchblende of Colorado Front Range, confirmed by study: 492.
Colorado—
General: pitchblende in more than 20 vein deposits: 455.
Front Range Mineral Belt: pitchblende deposits with hypogene zonal distribution: 458.
Boulder County—
Grand Island Mining District—
Caribou mine: Geiger-Mueller survey: 484; geology: 484; mineralization: 484; mineralogical examinations: 484; mineralogy: 484; ore zones vary from a few inches to 15 ft. in width and include silver, lead, zinc, and iron minerals with pitchblende: 484; pitchblende: 53, 102; pitchblende in silver fissure veins in shear zones in quartz-monzonite stock: 484; pitchblende in veins of the quartz-sulfide-carbonate type, with a little cobalt: 455; results of Geiger-Mueller counter studies showed no radioactivity on the surface despite presence of pitchblende at the 1040 ft. level and its corresponding radioactivity: 484.
Radium vein: colloform banding in ore: 507; Geiger counter survey of dumps and underground workings showed presence of uraninite: 507; paragenesis of vein filling; mineralization in two stages, with uraninite deposited in the later stage: 507.
Gilpin County—
Wood and Kirk mines, Quartz Hill: pitchblende ore with average grade of 0.2% U_3O_8: 394.
Colorado Mineral Belt
Central Part—
Alma Mining District: uranium associated with base and precious-metal veins; pitchblende present: 477.
Leadville Mining District: uranium as coatings on fracture surfaces or disseminations in country rock; pitchblende present: 477.
St. Kevin Mining District: uranium associated with base and precious-metal veins; pitchblende present; also as coatings on fracture surfaces and disseminations in country rock; torbernite and sooty pitchblende (?) present, probably alteration products of primary pitchblende: 477.
Southwest Part—
Lower Uncompahgre Mining District: uranium associated with base and precious-metal veins; pitchblende present: 477; zonal relationship since uranium is close to boundary between pyrite-gold-base metal core and outer silver-lead-zinc zone: 477.
Red Mountain Mining District: uranium associated with pyritic veins and volcanic copper-lead-silver breccia pipes; pitchblende present: 477.
Upper Uncompahgre Mining District: uranium as coatings on fracture surfaces or disseminations in country rock; pitchblende present: 477.
Colorado Plateau
General: 48, 267, 405, 411.
Accessibility: 440.
Age determinations: average Pb^{206}/U^{238} age about 71 million years for 40 samples containing over 0.1% U, with average Pb^{207}/Pb^{206} age of 425 million years: 492; age discrepancy resulting from selective loss of U^{238} or addition of old radiogenic lead: 492; assuming calculated ages to be close to true ages of ore, uranium introduced into sediments, probably, in late Mesozoic or early Tertiary, contrary to earlier belief that uranium ores formed in Triassic and Jurassic sediments during or soon after deposition: 492; corrections to bring ages into agreement increase the Pb^{206}/U^{238} age to 81 million years while additions of old radiogenic lead lower it to 60 million years: 492; determinations by Pb/U and Pb/Pb/methods ratio: 492.
Bedded uranium deposits in Morrison formation: Colorado: 486; Utah: 486.
Bedded uranium deposits in post-Morrison formations: map showing: 486; Utah: 486.
Bedded uranium deposits in Navajo sandstone or San Rafael group: map showing: 486; Colorado: 486; Utah: 486.
Bedded uranium deposits in pre-Navajo formations: map showing: 486; Colorado: 486; Utah: 486.

Biogeochemical studies made for deposits in the Salt Wash sandstone member and Brushy Basin shale member of the Jurassic Morrison formation, chiefly in the Thompsons district, Utah: 409.
Bonuses to encourage mining: 163, 441, 497.
Carnotite Deposits—
General: 20, 405, 430, 444.
Arizona, Colorado, New Mexico, and Utah: 441; spotty and scattered deposits: 501.
Colorado: 22; carnotite field in southwest part of state: 407; carnotite in small, widely scattered deposits; U_3O_8 content 0.1 to 0.3%: 457.
Colorado, New Mexico, and Utah: 407.
Entrada formation: 63; sandstone: 22, 501
Morrison formation: 22, 440; stratigraphically controlled carnotite deposits in Salt Wash sandstone member: 509.
Salt Wash member of Morrison formation: 63, 267; scattered erratically over Arizona, Colorado, New Mexico, and Utah: 431; Shinarump conglomerate, and Entrada sandstone: 501.
Shinarump conglomerate: 22, 267, 501.
Triassic and Jurassic sandstones: 409.
Utah: 22; carnotite in eastern part: 407; carnotite in small, widely scattered deposits; U_3O_8 content 0.1 to 0.3%: 457.
Companies engaged in mining activities: 497.
Description of ore deposits: 440.
Development of uranium mining program: 497.
Exploration by U.S.B.M.: 440.
General characteristics of uranium deposits: 497.
Geology: 405, 407, 431, 440, 497.
Government operations: 431.
Historical development of mining program: 431.
Historical geology: 497.
History: 440, 497.
Map: showing locations and types of uranium deposits: 443, 455, 486, 493, 509.
Metalliferous vein deposits of uranium: map showing: 486; Colorado: 486; Utah: 486.
Mineralogy: 405.
Mining development work: 440.
Mining methods and operations: 431.
Origin: 13, 22, 407, 431; deposition by solution: 444; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431; uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Physiography: 440.
Pitchblende: generally replaces cell walls of plants while copper sulfides fill cells: 485; in sedimentary rocks, usually in lower Chinle and Shinarump formations: 485; occurs with sulfides of copper or in asphaltic bodies, but, in both cases, associated with fossil plants or beds rich in organic debris: 485.
Property and ownership: 440.
Prospecting information like claim staking, equipment used, etc.: 497.
Sampling and metallurgy work on drill cores: 440.
Sandstone-type deposits: asphaltite deposits: 62; carnotite deposits: 62; copper-uranium deposits: 62; roscoelite deposits: 62.
U.S.A.E.C. mining district divisions: map showing: 486.
U.S.A.E.C. uranium development program: 430, 441.
U.S.A.E.C.'s buying schedule and policies for carnotite ores: 441.
U.S.G.S. drilling program carried out over area: produced geologic logs of about 2500 drill holes: 501.
Uranium content averaged 0.25% U_3O_8 though some of the fossil plant material is richly mineralized: 501.
Uranium mills: 407, 430, 440.
Uranium orebodies are irregular, elongate tabular masses in lenses essentially parallel to sandstone beds and occur in sandstone beds near top of Salt Wash sandstone member or in basal conglomerate of Brushy Basin shale member of Morrison formation: 409.
Uranium ore prices and bonuses: 430.
Uses of ore mined: 497.
Volcanic debris in uraniferous sandstone: uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clay minerals: 499; characteristics of deposits: 499; evidence indicates volcanism occurred during and just after the time the host rocks were accumulating but that later igneous activity was of primary importance in origin of uranium ore deposits: 499; geology of ore-bearing formations: 499; mineralogical examinations of clay samples from Colorado and Utah by: microscopic examination: 499, petrographic examination: 499, X-ray examination: 499; origin of deposits: 499; petrography: 499; presence of volcanic debris altered to clays: 499; processes involved in ore deposition: 499; relation of uranium ore to clays: 499; relation of uranium ore to fossil wood: 499; structure: 499; suggestions for future work on deposits along geologic, chemical, and physical lines: 499.
Work of small scale operators: 431.
Colorado—
General: carnotite deposits stratigraphically controlled in Morrison formation: 443.
Bedded uranium deposits in Morrison formation: map showing: 486.
Bedded uranium deposits in Navajo sandstone or San Rafael group: map showing: 486.
Bedded uranium deposits in pre-Navajo formations: map showing: 486.
Metalliferous vein deposits of uranium: map showing: 486.
Utah—
Bedded uranium deposits in Morrison formation: map showing: 486.

URANIUM OCCURRENCES (contd.)
Bedded uranium deposits in Navajo sandstone or San Rafael group: map showing: 486.
Bedded uranium deposits in post-Morrison formations: map showing: 486.
Bedded uranium deposits in pre-Navajo formations: map showing: 486.
Metalliferous vein deposits of uranium: map showing: 486.
Copper-Uranium Deposits
Utah—
Emery County—
San Rafael Swell—
Green Vein group: 21.
Pay Day claim: 21.
Garfield County—
Escalante-Circle Cliffs area—
Circle Cliffs: 509.
Blue Jay claim: 21.
Falling Star claims: 21.
Oak Creek prospect 17 mi. NE of Boulder: 509.
Spotted Dog claim: 509.
San Juan County—
White Canyon District—
White Canyon: uranium and copper minerals in Shinarump conglomerate as disseminated deposits in sandstones and as veins along fractures, sometimes as replacements in logs; similar deposits of lower grade in Chinle formation and in Moenkopi formation: 401; geology: 401; grade: 401; localization of deposits by uranium ore guides: 401, chemical controls: 401, general geologic controls: 401, relation to channel fills: 401, structural controls: 401; mineralogy: 401; origin: 401; production: 401; structure: 401.
Ace of Hearts claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bankrupt claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bear claim: copper-uranium deposit with 0.05–0.1% U: 401.
Bell claim: copper-uranium deposit with 0.1–0.3% U: 401.
Bridges claim: copper-uranium deposit with 0.01–0.05% U: 401.
Butler's claim: copper-uranium deposit with 0.05–0.1% U: 401.
Cub claim: copper-uranium deposit with 0.05–0.1% U: 401.
Dead Buck claim: copper-uranium deposit with 0.05–0.1% U: 401.
Found claim: copper-uranium deposit with 0.1–0.3% U: 401.
Four Aces claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey Canyon No. 4 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Frey claim: copper-uranium deposit with 0.05–0.1% U: 401.
Frey No. 1 claim: copper-uranium deposit with 0.01–0.05% U: 401.
Frey No. 2 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Gonaway-North Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Happy Jack mine: copper-uranium deposit with more than 0.3% U: 401.
Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Hideout No. 1 mine: in Shinarump conglomerate: 490.
Jacobs Chair claim: copper-uranium deposit with 0.05–0.1% U: 401.
Jerry claim: copper-uranium deposit with 0.05–0.1% U: 401.
Markie claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback (Old Jackpot) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Notch claim: copper-uranium deposit with 0.01–0.05% U: 401.
Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Posey mine: copper-uranium deposit with more than 0.3% U: 401.
Red Canyon No. 1 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Saddle claim: copper-uranium deposit with 0.01–0.05% U: 401.
Scenic No. 2 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Scenic No. 4 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scotty claim: copper-uranium deposit with 0.01–0.05% U: 401.
Standard claim: copper-uranium deposit with less than 0.01% U: 401.
Sunrise claim: copper-uranium deposit with 0.01–0.05% U: 401.
Unknown claim: copper-uranium deposit with less than 0.01% U: 401.
Uracop claim: copper-uranium deposit with 0.01–0.05% U: 401.
W.G.J.N.W. claim: copper-uranium deposit with less than 0.01% U: 401.
W.N. claim: copper-uranium deposit with 0.01–0.05% U: 401.
White Canyon No. 1 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Woodenshoe (?) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Yellow John claim: copper-uranium deposit with more than 0.3% U: 401.
Zebra claim: copper-uranium deposit with less than 0.01% U: 401.
White Canyon-Red Canyon District: 20.
Uintah County—
Uinta Basin: 509.
Washington County—
Silver Reef Mining District: 20, 478.
Fort Pierce: 21.
Silver Reef: 509.
Wayne County—
Capitol Reef Monument—
Oyler mine: 509; (called here: Oiler Tunnel, Blue Bird claims): 21.
Northern part: 21.
Fluorite, Uranium-bearing
Colorado—
General: 95.
Boulder County—
Jamestown: uraniferous fluorite breccia

zones with pitchblende, uraninite, autunite, torbernite in fluorite-sulfide deposit: 504.
Blue Jay mine: uranothorite in fluorite breccias: 474, 475.
Burlington mine: uraniferous fluorite breccia zones worked to depths of 600 ft.: 504.
Nations Treasure mine: torbernite on fractures in fluorite in fluorite-sulfide deposit: 504.
El Paso County—
St. Peters Dome: kasolite in fluorite-quartz-sulfide deposits: 504.
Utah—
General: 95.
Beaver County—
Indian Creek: autunite in fluorite-quartz-sulfide deposits: 504.
Staats mine: autunite, uranophane in fluorite: 504.
Juab County—
Honeycomb Hills: uranium minerals as coatings on fluorite in fluorite-quartz-sulfide deposits: 504.
Thomas Range: uraniferous fluorite pipes with carnotite: 504.
Bell Hill group of claims owned by Donald, Delbert, and T. E. Searle and Harold Ruthiford and leased to G. P. Spor: fluorite sample contained 0.4% uranium: 488.
Fluorine Queen property: irregular uraniferous fluorite pipe with carnotite: 504.
Fluorite (Original Spor) Group owned by G. P. Spor: less radioactive than Bell Hill and Harrisite groups but composite chip sample assayed 0.016% eU: 488.
Harrisite claims owned by E. D. and E. T. Harris: fluorite sample contained 0.25% uranium: 488.
Thursday property: uraniferous fluorite veins: 504.
Piute County—
Farmer John claims: uranium mineralization with fluorite; leased by Bullion Monarch Mining Co. for fluorite mining and, later, for uranium development: 522.
Limestones, Uranium-bearing
Colorado—
Jefferson County—
Leyden coal mine: uranium minerals in limestone of Laramie formation of Cretaceous age: 509.
Utah—
General: 27.
Northeast Part: uranium, possibly of syngenetic origin, in Uintah formation: 426.
Maps
Location and Types of Uranium Deposits—
Colorado: 426, 443, 455, 486, 493, 504, 509.
Colorado Plateau: 443, 455, 486, 493, 509.
United States: 426, 443, 455, 486, 493, 504, 509.
Utah: 426, 443, 455, 486, 493, 504, 509.
Navajo Indian Reservation
General—
Arizona, New Mexico, Utah: carnotite: 161.
Utah: Navajos may reassign uranium mining rights: 178.
Opal, Uranium-bearing
Utah—
Piute County—
Marysvale area—
J. and L. alunite mine: in adit; material similar to opal but unusual green fluorescence like that of some hyalite: 451.
Trinity mine: in old workings; has brilliant green fluorescence: 451.
Origin
Colorado—
Carnotite: 13, 22; probably syngenetic in Morrison and Entrada formations: 415; probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Hydrothermal solutions, precipitation from: Black King prospect: 449.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Colorado Plateau—
Carnotite: 13, 22, 407; probably syngenetic in Morrison and Entrada formations and Shinarump conglomerate: 415; probably from groundwater solutions migrating through ore-bearing beds soon after sand accumulated, with precipitation resulting from slight changes in chemical composition of solutions, perhaps in presence of decaying organic material: 417; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
United States—
Sedimentary deposits of carnotite: 459.
Sedimentary uranium deposits: 34.
Utah—
Carnotite: 13, 22; probably syngenetic in Shinarump conglomerate at Silver Reef: 415; probably due to circulation of groundwaters in Salt Wash member of Morrison formation after deposition of the Salt Wash sands and shales: 431.
Copper-uranium deposits:
White Canyon: 401.
Happy Jack mine: 412.
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and

URANIUM OCCURRENCES (contd.)
Chinle formation, which also contain volcanic debris altered to clays: 499.
Uranium deposits at Marysvale: 451
Phosphates, Uranium-bearing
General—
Low grade uranium ores: Utah: 306.
Utah: low grade uranium ores: 306.
Shinarump Formation
General—
Utah—
White Canyon, San Juan County: uranium ore deposition controlled by channels in Shinarump formation with carbonaceous matter and lithologic changes as intrachannel controls: 466; uranium ore usually in porous, carbonaceous sandstone above Shinarump siltstone: 466.
United States
General: 53, 90, 102, 267, 411.
Colorado Plateau: carnotite deposits: 62, 120, 430; carnotite deposits in Salt Wash and Entrada formations: 63.
Copper-uranium deposits: southwest part: 21.
Low grade Uranium Deposits:
Black shales: 267.
Phosphates: 267.
Maps showing locations and types of uranium deposits: 426, 443, 455, 486, 493, 504, 509.
Origin:
Sedimentary deposits of carnotite: 459.
Sedimentary uranium deposits: 34.
Sedimentary deposits of carnotite: geology: 459; origin: 459; production: 459; utilization: 459.
Sedimentary uranium deposits: geology: 34; mineralogy: 34; origin: 34.
Southwest part: copper-uranium deposits: 21.
Utah
General: 12, 13, 25, 48, 118, 395.
Carbonaceous Shales, Uranium-bearing:
Deseret limestone (black shale and phosphatic zone at base): possible uranium source: 462.
Mississippian Brazer limestone (phosphatic portion): possible uranium source: 462.
Swan Peak quartzite (phosphatic portion): possible uranium source: 462.
Carnotite: 1, 7, 86; in sandstone: 46; results of extraction processes: 419.
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Deseret limestone (black shale and phosphatic zone at base): possible uranium source: 462.
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General: 95.
Limestones: Uranium-bearing-
General: 27.
Maps showing location and types of uranium deposits: 426, 443, 455, 486, 493, 504, 509.
Mississippian Brazer limestone (phosphatic portion): possible uranium source: 462.
Morrison formation: carnotite: 22.
Northeast part: uranium, possibly of syngenetic origin, in freshwater limestone of Uintah formation: 426.
Origin: carnotite: 13, 22; carnotite in Shinarump conglomerate at Silver Reef, probably syngenetic in origin: 415; uranium-bearing deposits in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Phosphates, Uranium-bearing—
Phosphate deposits: low grade uranium ores: 306.
Shinarump conglomerate: carnotite: 22.
Swan Peak quartzite (phosphatic portion): possible uranium source: 462.
Types—
Carnotite in sandstone deposits: 62.
Copper-uranium deposits: 62.
Hydrothermal vein deposits: 62.
Volcanic Debris in Uraniferous Sandstone:
Uranium-bearing deposits in Colorado and Utah in the Salt Wash sandstone and Brushy Basin shale members of Morrison formation, Shinarump conglomerate, and Chinle formation, which also contain volcanic debris altered to clays: 499.
Characteristics of deposits: 499.
Evidence indicates volcanism occurred during and just after the time the host rocks were accumulating but that later igneous activity was of primary importance in origin of uranium ore deposits: 499.
Geology of ore-bearing formation: 499.
Mineralogical examination of clay samples from Colorado and Utah by: microscopic examination: 499, petrographic examination: 499, X-ray examination: 499.
Origin of deposits: 499.
Petrography: 499.
Presence of volcanic debris altered to clays: 499.
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Relation of uranium ore to clays: 499.
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Structure: 499.
Suggestions for future work on deposits along geologic, chemical and physical lines: 499.
Beaver County—
Newton Mining District—
Sniffer and Mystery claims: secondary uranium minerals, autunite (?), metatorbernite (?) in argillized, silicified earlier Tertiary Bullion Canyon latite: 510; geology: 510; prospecting guides: 510; samples analyzed: 510.
Staats mine: autunite, uranophane in fluorites: 504.
Bibliographies: 9, 10.
Box Elder County—
Sierra Madre Mountain: uranium: 463.
Carbon County—
Cold (may mean Coal) Creek, 20 mi. N of Price: carnotite: 404.
Colorado Plateau—
Bedded uranium deposits in Morrison formation: map showing: 486.
Bedded uranium deposits in Navajo sandstone or San Rafael group: map showing: 486.
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Bedded uranium deposits in pre-Navajo formations: map showing: 486.

Carnotite: 22, 63; deposits in Salt Wash member of Morrison formation, scattered erratically over Arizona, Colorado, New Mexico, and Utah: 431; carnotite in small widely scattered deposits: U_3O_8 content 0.1 to 0.3%: 457.
Geology: 431.
Government operations: 431.
Historical development of mining program: 431.
Metalliferous vein deposits of uranium: map showing: 486.
Mining methods and operations: 431.
Origin of deposits: 431.
Work of small-scale operators: 431.
Daggett County—
General exploration government financed: 553.
Browns Park: carnotite: 34; tyuyamunite: 434.
Red Creek: carnotite: 67; tyuyamunite: 82.
Yellow Canary claims: tyuyamunite in fractured quartzite in vein structures: 493.
Emery County—
General: uvanite, disseminated in rocks: 2.
Flat Top SW of Temple Mt.: carnotite and other uranium minerals: 436.
Green River: carnotite: 418, 433, 511; carnotite: concentration process results: 418; carnotite: mineralogy: 418.
San Rafael Swell: carnotite: 41, 63, 404, 410, 425, 459; carnotite and other uranium minerals: 436; general: 483; geography: 483; highly uraniferous asphaltic sandstone in breached anticlinal structure: 426; mineralogy: 483; mining history: 483; regional and economic geology: 483; uranium in isolated orebodies on large anticlines and domes: 481; 18 mi. W of Green River; carnotite: 78; tyuyamunite: 82; near Tidwell: carnotite: 433.
Clifford Smith claim on NW side of mesa S of San Rafael River Bridge: moderate radioactivity: 483.
Copper Globe deposit: torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Dalton group SW of Hard Pan group: autunite and asphalt seams: 483.
Dexter group SW of Dalton group on point of mesa: uranium with asphalt pellets and carbonized twigs: 483.
Dirty Devil group, 15 claims covering butte beside Muddy River: uranium, vanadium: 483.
Dolly group, 4 claims, along N side of Family Butte: insignificant radioactivity: 483.
Gardell Snow's claim N side of small butte E of Family Butte: uranium in carbonaceous material: 483.
Green Vein group: copper-uranium deposit: 21.
Hard Pan group, adjoins Lone Tree group: uranium with carbonized wood (tree limbs): 483.
Hertz No. 1 claim along E side of mesa N of Family Butte: uranium in asphaltic sandstone: 483.
Lone Tree deposit: uraniferous asphalt in Triassic sandstones and conglomerates of the Shinarump and Chinle formations: 509.
Lone Tree group, 3 mi. SW of San Rafael River Bridge: autunite (?) seam carrying U_3O_8: 483.
Pay Day claim: copper-uranium deposit: 21.
Green Vein group and Brown Throne group, 30 claims on a mesa 2 mi. N of Family Butte: three claims developed show uranium, vanadium, and some association with copper: 483.
Red Canyon deposit: uraniferous asphalt in Triassic sandstones and conglomerates of the Shinarump and Chinle formations: 509.
San Rafael Mining District: carnotite: 241.
South Fork group, 3 claims N side of Family Butte: no appreciable radioactivity: 483.
Temple Mountain: carnotite: 425, 438; carnotite and other uranium minerals: 436; carnotite derived from asphalt, which may be thucholite in this area: 509; carnotite, zippeite, and other secondary uranium and vanadium minerals coating asphaltite grains: 509; Consolidated Uranium Mines, Inc., claims: drilling operations: 550; uranium in Shinarump conglomerate: 550; uranium production: 550; uranium ore shipments: 550; pitchblende as minute grains, 1–10 microns in diameter, in ribbon or ellipsoidlike aggregates in asphaltites: 485; uraniferous asphaltite as void fillings, rounded pellets, veinlike fillings, and detrital grains in friable sandstone lenses in Shinarump conglomerate in old stream channels: 509; uraniferous asphalt in Triassic sandstone and conglomerates of the Shinarump and Chinle formations: 509; uranium in asphaltite: 21; uranium in large mine in Shinarump formations but not in channel deposit: 481; uranium minerals: 416, 434; uranium-bearing asphalts: 20; S of Green River: carnotite: 545.
Temple Rock: carnotite: 34, 78; tyuyamunite: 82; uranium ore in Shinarump conglomerate: 415.
Wickiup group, 19 claims, in Block Mt.: slight radioactivity: 483.
South Temple Wash: carnotite: 82.
Table Mountain: carnotite: 511.
Wildhorse Canyon: carnotite: 404, 433.
Garfield County—
Escalante-Circle Cliffs area—
Circle Cliffs: carnotite: 63; carnotite, carbonized wood, and radioactive iron oxide as uranium-bearing materials in copper-uranium deposit in Triassic Shinarump conglomerate: 509; uranium leases: 528; SE of Escalante: 28 uranium claims leased by New Park Mining Co.: 529.
Blue Jay claim: copper-uranium deposit: 21.
Dud No. 1 claim: uranium: 21.
Falling Star claims: copper-uranium deposit: 21.
Hot Shot claims: uranium: 21.
Moody claims: uranium: 210

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Waterpocket fold: highly uraniferous asphaltic sandstone in breached anticlinal structures: 426; uranium in isolated bodies on large anticlines and domes: 481.
Henry Mountains: carnotite: 86; uranium in ore deposits forming haloes around mountain masses and showing limonite and brown rust stains: 481; E and N of: carnotite: 464; E and SW flanks: carnotite: 78, 82.
Crescent Creek: carnotite: 78; carnotite, tyuyamunite: 82.
Little Rockies District—
Del Monte group: good grade uranium ore but small thin pockets: 482.
Ekker mine in Shootering Canyon: good grade uranium ore: 482.
North Wash District—
S.Y. Guthrie orebody: uranium: 482.
Unnamed deposit ¾ mi. N of Guthrie orebody: uranium: 482.
V.C.A. orebodies operated by Kay Hunt: uranium: 482.
Starlight claims NE side of Mt. Hillers: tyuyamunite: 434.
Trachyte Creek: carnotite: 78; carnotite, tyuyamunite: 82.
Trachyte District: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406; mineralization localized along flanks of stream channelways: 406; ore grade of seven channel samples, mainly from underground workings, gave weighted averages of 0.245% U_3O_8 (chem.) and 1.307% V_2O_5: 406; orebodies include mineralized logs and carbonaceous material with ore also in surrounding sandstone: 406; ore exposures limited to rims surrounding topographic highs like Farmers Knob, John Hill, and West Knob: 406; part of property worked by Darys Ekker under oral lease from V.C.A.: 406; V.C.A. doing some mining, including exploratory wagon-drilling: 406.
Blitz Nos. 1–7 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Farmers Knob: uranium ore exposures limited to rims surrounding topographic high: 406.
Group of mines 2 mi. E of pass between Mt. Hillers and Mt. Holmes: uranium ore of good grade, not worked: 482.
John Hill: uranium ore exposures limited to rims surrounding topographic high: 406.
June Bell Nos. 1–4 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Minnie Pearl Nos. 1 and 2 claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Straight Creek claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
Trachyte Nos. 1–20 claims owned by V.C.A.: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
V.C.A. claims: carnotite-vanoxite mineralization in Salt Wash member of Morrison formation: 406.
V.C.A. orebody on Farmers Knob operated by Darys Ekker: high-grade uranium ore: 482.
West Knob: uranium ore exposures limited to rims surrounding topographic high: 406.
Oak Creek prospect 17 mi. NE of Boulder: pitchblende, etc.: 21; radioactive asphaltite pellets: 509; torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Poison Springs, at confluence of Green and Colorado Rivers: uranium claims bought by V.C.A.: 540.
Spotted Dog claim: torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Grand County—
General: carnotite: 471.
Cane Creek anticline: uranium: 481.
Corvusite Nos. 1, 2, and 3 claims on E slope of La Sal Mts.: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 1.12% U_3O_8: 440.
La Sal Mts.: uranium; bleached sandstone surrounding orebodies: 481; near Moab: carnotite: 33; W slope: carnotite: 104.
Mill Creek on Colorado (formerly Grand) River N of Moab: carnotite: 404.
Moab: carnotite: 511; carnotite carrying 3–4% uranium oxide: 470.
Pack Creek, La Sal Mts.: carnotite: 78; carnotite, tyuyamunite: 82.
Polar Mesa: 411.
Elva M. and adjoining claims: carnotite in saucer-shaped orebody, drilled by U.S.B.M., and showing from 0.05 to 0.24% U_3O_8 in the Elva M., Elva M. No. 2, and Mary No. 2 claims: 440.
Elva M. and Imp claims: carnotite: 410.
Polar Nos. 2 and 3 claims: carnotite in irregular well-defined rolls, drilled by U.S.B.M., and showing from 0.05 to 0.10% U_3O_8: 440.
Rim Rock and Rim Rock No. 2 claims: carnotite in large, thick, low grade orebody, drilled by U.S.B.M., and showing from less than 0.05 to 0.20% U_3O_8: 440.
Richardson: carnotite: 41, 78, 404, 410, 464, 476, 511; carnotite, tyuyamunite: 82; carnotite, etc.: 416; tyuyamunite, etc.: 434; on Colorado River: carnotite: 34.
Seven Mile Canyon: pitchblende replacing wood and rimming quartz and limestone pebbles: 485; uranium in Shinarump formation and at base of Chinle formation: 481.
Thompsons area—
Thompsons: carnotite: 82, 511; 22 mi. SE of: carnotite: 78.
Thompsons District, 15 mi. SE of Thompsons: biogeochemical studies of deposits

through study of distribution of selenium-indicator plants of *Astragalus* group; plant distribution controlled by selenium which is associated with uranium orebodies: 409; carnotite deposits in Morrison formation: 409.
Cactus Rat group, Thompsons: Minerals Engineering Co. operations: 413.
Flat Top No. 1 claim: carnotite in rolls, drilled by U.S.B.M., and showing from 0.05–0.67% U_3O_8: 440.
Red Vanadium group: carnotite in rolls, drilled by U.S.B.M., and showing from less than 0.05 to 0.26% U_3O_8: 440.
Thompsons Springs, 10 mi. S of: carnotite: 404.
Uvanco or Yellow Jacket mine: carnotite: 410.
Yellow Cat District—
Eli Malich's Lucky Day claim: eligible for U.S.E.A.C. bonus: 544; uranium oxide, production: 544.
L.A. Sutherland's Sock claim: eligible for U.S.A.E.C. bonus: 544; uranium oxide, production: 544.
Juab County—
Fish Springs Mining District—
Honeycomb Hills: claims owned jointly by H. P. Bertelsen, Don and Stewart Sheldon, J. W. McAfee, and Owen Bauer: 489; geology: 489; mineralogy: 489; size and grade of deposits: 489; some radioactive fluorite: 489; uranium deposits in tuffs: 489; uranium minerals as coatings on fluorite in fluorite-quartz-sulfide deposits: 504; uranium-bearing minerals first discovered in tuffs in 1950 by H. P. Bertelsen: 489; uranospinite: 493.
Spider No. 1 claim about 15 mi. W of SW end of Fish Springs Mts.: ore sample with 0.17% U: 489; samples with 0.009–0.053% eU: 489; three samples from Pit No. 3 with 0.02, 0.07, and 0.19% U: 489; uranium-bearing minerals (possibly autunite, uranophane) in tuffs: 489.
Indian Creek: autunite in fluorite-quartz-sulfide deposits: 504.
Thomas Range: carnotite in fluorite deposits in vein structures: 493; uraniferous fluorite pipes with carnotite: 504.
Bell Hill group of claims owned by Donald, Delbert, and T. E. Searle and Harold Ruthiford and leased to G. P. Spor: uranium in fluorite; sample contained 0.4% uranium: 488.
Fluorine Queen property: irregular uraniferous fluorite pipes with carnotite: 504.
Fluorite (Original Spor) Group owned by G. P. Spor: uranium in fluorite; composite chip sample assayed 0.016% eU: 488.
Harrisite claims owned by E. D. and E. T. Harris: uranium in fluorite; sample contained 0.25% uranium: 488.
Thursday property: uraniferous fluorite veins: 504.
Tintic Mining District—
Centennial Eureka mine: zeunerite: 82, 421.
Kane County—
Bulloch claims near Orderville: autunite, carnotite, torbernite, and uraniferous carbonized wood, disseminated or coating pebbles and fracture surfaces in sandstones of the Cretaceous Dakota or Jurassic Summerville formations: 509.
Pahreah: carnotite: 511; 9 mi. S of: autunite, uranospinite: 78, 82.
Paria Road claims Nos. 1–6, E of Kanab: uranium: 21.
Virgin River: torbernite: 82.
Piute County—
Marysvale area: alteration zones showing a sequence of clay minerals, silicification, alunitization, or pyritization: 450; analysis of relationship between alteration and uranium mineralization: 450; autunite: 526; autunite, processed: 548; autunite, schroeckingerite, torbernite, uraninite, etc.: 267; autunite, some uraninite; 175 t. ore shipped daily: 547; economic deposits of primary and secondary uranium minerals in altered vein structures: 493; geology: 451, 495; geology and descriptions of uranium mines: 522; mapping as aid in establishing the correlation between alteration and rock types: 450; mineralization: 451; more significant channels of alteration mapped: 450; origin of deposits: 451; pitchblende: 102; pitchblende and secondary uranium minerals in structurally controlled uranium deposits: 443; pitchblende in veins of the fluorite-sulfide-quartz type: 455; radioactivity: 451; recent ore shipments assayed 0.8% U_3O_8: 441; rock alteration: 451; structure: 451, 495; U.S.A.E.C. uranium ore purchasing depot operated by A.S. & R. Co. at Marysvale: 53, 441, 525, 526, 531; sampling methods and pricing described: 522; uraninite: 48, 53; uraninite and secondary uranium minerals in various mines and prospects: 522; uraninite, autunite, torbernite: 441; uraninite, fine grained mixed sample examined by X-ray fluorescence method giving partial chemical analysis: 448; uraninite, mineralogical studies of specimens: 445; uranium development: 530; uranium mineral deposits: 495; uranium ore purchase schedule for typical autunite-torbernite ores: 522; uranium production: 77; uranium-bearing veins with both oxidized uranium minerals and uraninite and fluorite, mostly in quartz monzonite or fine-grained granite, with some uranium in Bullion Canyon volcanic series in argillic alteration zones, and migratory secondary uranium mineralization along fractures in Mt. Belknap volcanics: 450; weathering produced following zonation of uranium minerals: autunite, schroeckingerite, torbernite, and uranophane at surface, zone dominantly uranophane with abundant autunite and torbernite in lower parts, then zone with sooty pitchblende and relict masses of primary pitchblende: 493.
Antelope Range, high elevation on W slope: alteration zone in rhyolite showed

URANIUM OCCURRENCES (contd.)
no significant uranium mineralization: 447.
Buddy claim, Bertelson's deposit: autunite: 479.
Buddy mine: autunite, a little pitchblende: 495; mineralization: 495; pitchblende: 429; rock types: 495; structure: 495.
Bullion Monarch mine: mineralization: 495; pitchblende, autunite, meta-torbernite, schroeckingerite, torbernite, uranophane: 495; rock types and alteration: 495; structure: 495; uraninite in small amounts and in drill holes in vicinity, autunite: 451; uranium minerals: 429.
Bullion Monarch open pit on west side of Pratt Peak: first uranium mineralization in area found there over 60 years ago and rediscovered by Pratt Seegmiller in 1940: 522; equipment owned and operated by Atherley brothers for Bullion Monarch Mining Co.: 522; largest producer in area: 522; schroeckingerite in rhyolite and secondary uranium mineralization between rhyolite and crushed gougey contact: 522.
Bullion Monarch Mining Co. operations: autunite ore easy to mill and reduce: 526; firm has indicated reserves of 500,000 t. autunite with U_3O_8 content on total tonnage ranging from 0.7–0.26%: 526.
Bullion Monarch Mining Co. properties: autunite, torbernite: 532; new autunite cut: 552; uranium shipments: 552.
Bullion Monarch prospect: uranium in open cuts along contact between Mt. Belknap rhyolite and quartz monzonite: 447.
Claims of D. MacIntosh and J. Henry, 1½ mi. W of Marysvale: uranium: 527.
East Slope claims: autunite, etc.: 429.
East Slope No. 2 deposit: autunite, meta-torbernite, schroeckingerite, and uranophane, distributed along face of open-cut in two main zones about a core of hematite-alunite-quartz kaolinite rock: 493; secondary uranium minerals associated with alunitic and clay alteration zones in veinlike structure within hornfels: 493.
Farmer John claims: owned by John Sargeant and leased by Bullion Monarch Mining Co. for fluorite mining and, later for uranium development: 522.
Farmer John claims of Bullion Monarch Mining Co. near Marysvale: uranium: 541; uranium mineralization with fluorite: 522.
Farmer John open pit, Bullion Monarch Mining Co.: autunite, pitchblende: 479.
Freedom claims located by Pratt Seegmiller in 1948: autunite with some torbernite: 522.
Freedom lease, V.C.A.: autunite, pitchblende: 479.
Freedom No. 1 (Seegmiller) mine: autunite, trace of pitchblende, schroeckingerite, torbernite: 495; mineralization: 495; rock types and alteration: 495; structure: 495.
Freedom No. 2 mine: schroeckingerite, torbernite, uranophane: 495; autunite, uranophane in fractures in rhyolite: 451; mineralization: 495; most important producer of secondary uranium ore in district: 495; rock types: 495; structure: 495; uranium minerals: 429.
Freedom prospect: hydrothermal alteration and uranium mineralization in quartz monzonite: 447.
J. and L. alunite mine: uranium-bearing material similar to opal in adit but unusual green fluorescence like that of some hyalite: 451.
Opal, Uranium-bearing—
J. and L. alunite mine: in adit: 451.
Trinity mine: in old workings: 451.
Papsy's Hope prospect owned by J. P. Fullmer: autunite on fracture surfaces in altered feldspar porphyry, a part of the Bullion Canyon volcanics: 442; autunite samples contain 0.013–0.030% eU: 442; autunite, etc.: 429; uranophane as zone forming halo overlying autunite-bearing vein and underlying leached clay: 451; geology: 442; rock alteration and silicification: 442.
Prospector group of claims located by April Smith, and L. J. and Merlin Anderson: uranium located in shear zone: 522; leased by V.C.A. for development along with Seegmiller's claims (i.e. Freedom and Freedom No. 1 mines): 522.
Prospector lease, V.C.A.: autunite, pitchblende: 479.
Prospector mine under lease by V.C.A.: alteration in quartz monzonite showing increased argillic alteration as uranium-bearing zones are approached: 447; mineralization: 495; mineralogical studies on quartz monzonite sample by thin-section, X-ray diffraction, differential thermal analysis, and electron microscope examination methods: 447; pitchblende: 429; 'pitchblende, a calcium-uranium-oxide mineral (analogue of fluorite), autunite, torbernite, uranophane: 495; pitchblende in black, sooty and massive form: 495; quartz monzonite has andesine, biotite, epidote, olivine, orthoclase, quartz, sphene, and zircon with secondary introduction of alunite, fluorite, pyrite, and uraninite as well as quartz, mixture of quartz and feldspar, and sericite: 447; rock types: 495; structure: 495; sooty black uraninite mixed with fine-grained pyrite and fluorite within 60 ft. of surface: 451; uraninite, disseminated with pyrite, limonite, and some schroeckingerite in quartz monzonite: 447; uranium deposits entirely in quartz monzonite in parts showing alteration effects: 447; uranium-bearing breccia covered with black sooty uraninite and associated with pyrite, fluorite, and uraninite: 447; uranium-bearing clay containing uraninite associated with pyrite and limonite and a little secondary fluorite and alunite: 447.

Sniffer claims: uranium minerals: 429.
Trinity mine: uranium-bearing opal in old workings; has brilliant green fluorescence: 451.
V.C.A. claims: autunite: 523.
V.C.A. properties: autunite, pitchblende, torbernite, uraninite: 532.
Yellow Canary prospect: autunite, uranophane (?): 495; mineralization: 495; rock types and mineralization: 495; structure: 495.
San Juan County—
Abajo Mountains: carnotite: 404; uranium in ore deposits forming haloes around mountain masses with bleached sandstone surrounding orebodies: 481.
Abe Day's Vanadium Queen claim: uranium oxide, production: 544; eligible for U.S.A.E.C. Bonus: 544.
Big Indian Valley N of Monticello: carnotite: 78, 82.
Big Indian Wash—
Mi Vida mine, on Mi Vida claim and owned by Charles Steen: heavy black ore resembling pitchblende and uraninite with no carnotite found in belt 72 ft. below surface; assay of core gave 0.34 to 5% U_3O_8: 465; Utex Exploration Co. formed, with Steen and his mother as principal stockholders, to develop mine and adjacent claims: 465; first ore shipment made Dec. 1952 and total ore shipped increased to $1,000,000's worth by Aug. 1953: 465; ore found on other parts of Mi Vida claim averaged better than 0.50% U_3O_8 with some as rich as 21% and handpicked samples ranging up to 88%: 465; Steen stockpiling all ore above 20% in hopes of collecting A.E.C. bonus for first 20 t. of non-carnotite, non-roscoelite ore assaying at least 20% discovered in U.S.: 465; high lime content only disadvantage of Steen ore, which is being stored at Monticello mill until proper treatment facilities become available for extraction of its uranium: 465.
Other uranium claims in area near Mi Vida claim: uranium deposits being developed by owners or under leases to companies and individuals: 465.
Cane Springs Pass S of Moab: carnotite: 34.
Bridger Jack Flat: carnotite: 437.
Browns Hole area: carnotite: 396.
Bull Canyon area: uranium claims: 524.
Cottonwood Canyon District—
Basin claim: ore horizon in sandstone, drilled by U.S.B.M.: 440.
Big Hole mine, largest in district and owned by Blanding Mines Co.: carnotite in layers in sandstone, drilled by U.S.B.M.: 440.
Birthday, Shale, East Bank, Found No. 2, and Lost claims: carnotite in layers in sandstone, drilled by U.S.B.M., and showing from less than 0.05 to 0.30% U_3O_8: 440.
Blue Bird area, about 1½ mi. W of Cliffhouse claim and owned by V.C.A.: carnotite in layers in sandstone, drilled by U.S.B.M., and showing less than 0.05% U_3O_8: 440.
Hangover Nos. 1 and 2 and Ridge Nos. 1 and 2 claims, on small tributary of Cottonwood Creek: carnotite in massive, thick, lenticular sandstone, drilled by U.S.B.M., and showing from zero to less than 0.05% U_3O_8: 440.
Dry Valley: carnotite in Morrison formation: 415.
Dry Valley N of Monticello: carnotite: 78, 82.
East Canyon: carnotite, tyuyamunite: 82.
Elk Ridge anticline: uranium in isolated orebodies on large anticlines and domes: 481.
Grey Dawn mine: uraninite, assaying about 64% U_3O_8: 480; uraninite, associated with carnotite ores of Salt Wash sandstone member of Morrison formation: 480; uraninite, in three podlike occurrences: 480; uraninite with beta-uranotil, carnotite, gummite: 480.
La Sal Mountains: carnotite: 396; torbernite: 82; uranium in ore deposits forming haloes around mountain masses with bleached sandstone surrounding orebodies: 481.
Lisbon (not Lisburne) Valley N of Monticello: carnotite: 78, 82.
Monument Valley: all uranium deposits found to date occur in channels in Shinarump formation: 481; carnotite: 62, 427; uplift: uranium in isolated orebodies on large anticlines and domes: 481.
Skyline mine: uranium in channels in Shinarump formation: 481.
Whirlwind mine: uranium in channels in Shinarump formation: 481.
Montezuma Canyon: carnotite: 503; uranium and radium in silts on canyon floor: 503.
Navajo Indian Reservation: carnotite: 161; Navajos may reassign uranium mining rights: 178.
Navajo Mt.: uranium: 169.
Spanish Valley anticline, NW faulted segment: uranium in isolated orebodies on large anticlines and domes: 481.
White Canyon District—
White Canyon: 411; carnotite: 63; copper-uranium deposits in Shinarump conglomerate as disseminated deposits in sandstones and as veins along fractures, sometimes as replacements in logs; similar deposits of lower grade in Chinle formation and in Moenkopi formation: 401; geology: 401; grade: 401; localization of deposits by uranium ore guides: 401: chemical controls: 401, geologic controls: 401, relation to channel fills: 401, structural controls: 401; mineralization, pitchblende, secondary uranium minerals including johannite, phosphuranylite, schoepite-becquerelite, torbernite, uranophane, and zippeite, and uranium in carbonized wood, iron and manganese oxides, and veinlets of hydrocarbon: 401; mineralogy: 401.
Ore Criteria—
Features apparently unrelated to ore deposits: conglomerate: 401; freckled limonite: 401; hydrous mica:

URANIUM OCCURRENCES (contd.)
401; massive sandstone: 401; these have served as prospecting guides in other areas but have not been useful in White Canyon and are considered unimportant in finding concealed deposits: 401.
Features found only in mineralized areas: alunite (?): 401; hydrocarbons: 401; secondary copper sulfates and carbonates: 401; sulfide minerals: 401; visible uranium minerals: 401.
Features found in unmineralized as well as mineralized areas: association of several features may indicate favorable prospecting areas: 401; bleaching and alteration of Moenkopi formation: 401; carbonized wood fragments and vegetal material: 401; channel filling: 401; facies change within Shinarump conglomerate: 401; fracturing: 401; iron and manganese staining: 401; jarosite (?): 401;
origin: 401; pitchblende disseminated in Shinarump conglomerate and associated with copper sulfides, a little cobalt, and secondary uranium minerals in sandstone: 455; pitchblende in sedimentary rock, replacing cell walls of fossil plants while copper sulfides fill cells: 485; production: 401; structure: 401; 8 mi. from Hite: carnotite: 78.
Ace of Hearts claim: copper-uranium deposit with 0.01–0.05% U; 401.
Bankrupt claim: copper-uranium deposit with 0.01–0.05% U: 401.
Bear claim: copper-uranium deposit with 0.05–0.1% U: 401.
Bell claim: copper-uranium deposit with 0.1–0.3% U: 401.
Bridges claim: copper-uranium deposit with 0.01–0.05% U: 401.
Butler's claim: copper-uranium deposit with 0.05–0.1% U: 401.
Cub claim: copper-uranium deposit with 0.05–0.1% U: 401.
Dead Buck claim: copper-uranium deposit with 0.05–0.1% U: 401.
Found claim: copper-uraniun deposit with 0.1–0.3% U: 401.
Four Aces claim: copper-uranium deposit with 0.01–0.05% U: 401.
Four Aces mine in White Canyon: radioactive asphaltite pellets: 509.
Frey Canyon No. 4 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Frey claim: copper-uranium deposit with 0.05–0.1% U: 401.
Frey No. 1 claim: copper-uraniun deposit with 0.01–0.05% U: 401.
Frey No. 2 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Gonaway-North Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Happy Jack mine: carnotite in thin seam, drilled by U.S.B.M., and showing no U_3O_8, so work was to be abandoned: 440; channel structure: 412; copper-uranium deposit grading laterally from secondary uranium carbonates and sulfates at exposed cliff face to sulfides and pitchblende at mine workings 75 ft. underground: 509; copper-uranium deposit with more than 0.3% U: 401; geology: 412; horizontal bedding-plane control for pitchblende: 466; johannite associated with a large suite of secondary uranium minerals: 493; mineralogy: 412; no evidence of vertical control of primary ore: 466; origin: 412; pitchblende, etc.: 412; sequence of secondary uranium minerals from leached outcrops shows johannite and chalcanthite at surface, uranophane and torbernite a short distance in, and pitchblende, pyrite, chalcopyrite, chalcocite, and gersdorffite in interior: 493; stratigraphy: 412; uraninite: 48; uranium in channels in Shinarump formation and with bleached mudstone in Chinle formation: 481; uranium ore usually in porous carbonaceous sandstone above Shinarump siltstone: 466; uranium: ore deposition controlled by channels in Shinarump formation with carbonaceous matter and lithologic changes as intrachannel controls: 466; uranium production: 412.
Hideout mine: copper-uranium deposit with 0.1–0.3% U: 401.
Hideout No. 1 mine: bayleyite, schroeckingerite, in adit 100 ft. from cliff face: 490; copper-uranium deposit in Shinarump conglomerate: 490.
Jacobs Chair claim: copper-uranium deposit with 0.05–0.1% U: 401.
Jerry claim: copper-uranium deposit with 0.05–0.1% U: 401.
Markie claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback claim: copper-uranium deposit with 0.05–0.1% U: 401.
Mossback (Old Jackpot) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Notch claim: copper-uranium deposit with 0.01–0.05% U: 401.
Point claim: copper-uranium deposit with 0.05–0.1% U: 401.
Posey mine: copper-uranium deposit with more than 0.3% U: 401.
Red Canyon No. 1 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Saddle claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scenic No.2 claim: copper-uranium deposit with 0.1–0.3% U: 401.
Scenic No.4 claim: copper-uranium deposit with 0.05–0.1% U: 401.
Scotty claim: copper-uranium deposit with 0.01–0.05% U: 401.
Standard claim: copper-uranium deposit with less than 0.01% U: 401.
Sunrise claim: copper-uranium deposit with 0.01–0.05% U: 401.
Sunrise and Gonaway claims: uranium ore deposition controlled by channels in Shinarump formation with carbonaceous matter and lithologic changes as intrachannel controls: 466; uranium ore usually in porous carbonaceous sandstone above Shinarump silstone: 466.

Unknown claim: copper-uranium deposit with less than 0.01% U: 401.
Uracop claim: copper-uranium deposit with 0.01–0.05% U: 401.
W.G.J.N.W. claim: copper-uranium deposit with less than 0.01% U: 401.
W.N. claim: copper-uranium deposit with 0.01–0.05% U: 401.
White Canyon No. 1 claims: copper uranium deposit with 0.1–0.3% U: 401.
Woodenshoe (?) claim: copper-uranium deposit with 0.05–0.1% U: 401.
Yellow John claim: copper-uranium deposit with more than 0.3% U: 401.
Zebra claim: copper-uranium deposit with less than 0.01% U: 401.
White Canyon-Red Canyon District: copper-uranium deposit: 20.
Yellow Circle Group—
White Fawn and Yellow Circle claims: carnotite in sandstone lenses, drilled by U.S.B.M., and showing from zero to 5.20% U_3O_8: 440.
San Pete County—
RAJ prospect: torbernite or autunite and uraniferous carbonized wood in the Eocene Green River formation: 509.
Sevier County—
Wooley prospect: uranium minerals in Tertiary tuffs: 509.
Uintah County—
Snow claims: torbernite or autunite and uraniferous carbonized wood in Cretaceous Mesa Verde sandstone: 509.
Uinta Basin: torbernite and uraniferous carbonized plant fragments in copper-uranium deposit: 509.
Vernal on Ashley's Fork: carnotite: 464.
Washington County—
Silver Reef Mining District: copper-uranium deposit: 20; copper-uranium deposit with silver in Silver Reef sandstone member of Chinle formation: 478; mineralization: 478; origin: precipitation from solution in circulating groundwater of primary deposits in tuffs: 478; secondary enrichment: 478.
Chloride Chief claim: uranium: 21.
Duffin mine: uranium: 21.
Eloise claims: uranium: 21.
Fort Pierce, 13 mi. S of Hurricane: copper-uranium deposit: 21.
Rough Rider No. 2 claim: uranium: 21.
Silver Reef: autunite, carnotite: 82; carnotite, volborthite, and an unidentified uranium mineral, associated with cerargyrite, carbonized plant remains, and copper carbonates with abundant selenium: 509; copper-uranium-vanadium deposit in irregular lenses of sandstone with clay pellets, a part of Chinle formation of Triassic age: 509; some carnotite above the water table in White and Buckeye "reefs" (sandstone beds): 415; mines on: carnotite: 464.
Tecumseh mine: uranium: 21.
Washington: carnotite: 464.
Wayne County—
General: zippeite, crystalline powder in asphaltic sandstone: 2.
Capitol Reef Monument—
Capitol Reef: carnotite: 63; region: carnotite: 428.
Oyler mine near Fruita: high grade ore bodies at base of Shinarump conglomerate in old stream channels: 509; radioactive asphaltite pellets: 509; uranium samples from mine workings showed 1.5 to 4% eU and .33 to 1.22% U: 509; zippeite as coatings on mine walls, carbonized wood, and gypsum: 493; zippeite, torbernite, and other secondary uranium minerals with highly uraniferous carbonized wood and hydrocarbons, associated with copper sulfates and carbonates in podlike lenses at the base of the Shinarump conglomerate as copper-uranium deposit: 509.
Oyler mine (called here: Oiler tunnel, Blue Bird claims): copper-uranium deposit: 21.
Waterpocket fold: uranium in isolated orebodies on large anticline and domes: 481.
Fruita: 433; uranium minerals: 436; uranium sulphate: 78, 82; zippeite: 434.
Hanksville, 10 mi. N of: carnotite: 404.
Henry Mts.: uranium in ore deposits forming haloes around mountain masses and showing limonite and brown rust stains: 481; N end: carnotite: 78, 82.
Northern part: copper-uranium deposit: 21.
Poison Springs, at confluence of Green and Colorado Rivers: uranium claims bought by V.C.A.: 540.
Upheaval dome: uranium in isolated orebodies on large anticlines and domes: 481.
Weber County—
Ogden Canyon: uraninite: 82.

URANIUM ORE GUIDES

General
Geobotanical Guides—
Absorption of ore elements by plants: amount of uranium and vanadium absorbed by plants varies with species, time of year, part of plant, availability of elements in soil, proximity to contaminating sources like uranium mills, etc., and chemical composition of country rock: 409; availability of uranium and vanadium to plants, probably influenced by (a) clay content, (b) organic content, (c) acidity of soil, and (d) combination in which the elements occur: 409; much higher uranium content in plants growing near pitchblende deposits, although those growing on asphaltic sandstone or on limestone deposits also absorb uranium readily with maximum values considerably higher than those of plants associated with Colorado Plateau carnotites: 409; uranium content in plants greater in spring than in fall: 409; uranium content of seeds and roots may exceed that of leaves: 409.
Anomalous growth habits in plants: amounts of uranium and vanadium present in soils associated with carnotite deposits are commonly in the range retardative or even toxic to plant growth and show notable effects in the field: fine roots commonly decayed and fragmental: 409, large roots frequently

URANIUM ORE GUIDES (contd.)
containing deposits of unidentified greenish-yellow powdery material: 409, plants set fruit and mature early in the season with marked reddening of stem and seed and yellowing of leaves: 409, red and yellow coloration of leaves and stems may be due to molybdenum: 409; higher concentrations of uranium retard growth or inhibit root development in higher plants: 409; small amounts of uranium stimulate growth: 409.
Effect of chemical environment on plant growth near ore deposits: may restrict distribution of certain plants creating an indicator flora: 409; metabolism of plants affected by unusual amounts of ore minerals available to roots, so that plants show anomalous growth habits: 409; some plant species absorb and accumulate available elements in detectable quantities: 409.
General indicator plants: *Cowania mexicana*, cliffrose ("vanadium bush"), found over uranium deposits at Carrizo Mts., Arizona; Thompsons and Temple Mt., Utah; Phosphoria formation, Caribou Co., Idaho: 409; *Cryptantha flava*, cryptanthe, found over uranium deposits at Carrizo Mts., Arizona; Thompsons, Utah: 409; *Purshia tridentata*, a winter forage of the rose family, found over uranium deposits at Slick Rock, Colorado; Marysvale, Utah; Phosphoria formation, Bear Lake and Caribou Cos., Idaho, and Teton Co., Wyoming: 409.
Indicator plants: in different chemical environments may indicate various metallic deposits: 409; indicate mineralized ground by presence or absence: 409; literature mentions no specific uranium or vanadium indicator plants but association of selenium-indicator plants with carnotite deposits has led to their establishment as a method of uranium prospecting: 409; may or may not accumulate element sought: 409; sulfur-indicator plants may also serve as uranium indicators under favorable conditions: 409.
Plants shown by analyses to have absorbed uranium: apple seed: 409; apricot leaves, higher uranium content in spring than fall: 409; bahia: 409; birch leaves, higher uranium content in spring than fall: 409; budsage: 409; celery rootlets, taproot, root bark, and leaves: 409; dill roots, leaves, and seeds: 409; garlic bulblets and bulb skin: 409; goldenweed: 409; grape stem, seed, and skin: 409; juniper: 409; milkvetch (several varieties): 409; mistletoe branch, berry, leaves, and seed: 409; Mormon tea: 409; pear leaves, higher uranium content in spring than fall: 409; pine branches and needles: 409; plants in general, higher uranium content in seeds and roots than in leaves: 409; potato tuber: 409; quackgrass leaves and root: 409; rabbitbrush: 409; ricegrass: 409; sagebrush: 409; saltbush: 409; scrub oak: 409; shadscale: 409; singleleaf ash: 409.
Selenium-indicator plants: *Aster venustra*, woody aster, found over uranium deposits at Thompsons, Utah: 409; *Astragalus Pattersonii*, milkvetch, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons and Temple Mt., Utah: 409; *Astragalus Preussii var. arctus*, milkvetch, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons and Temple Mt., Utah: 409; *Astragalus Thompsonae*, milkvetch, found over uranium deposits at Carrizo Mts., Arizona; Thompsons and Temple Mt., Utah: 409; *Atriplex confertifolia*, shadscale, found over uranium deposits at Slick Rock, Colorado; Thompsons, Temple Mt., and Marysvale, Utah; Wamsutter, Wyoming: 409; *Grindelia squarrosa*, gumweed, found over uranium deposits at Thompsons, Utah: 409; *Oryzopis hymenoides*, Indian ricegrass, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons, Temple Mt., and Marysvale, Utah; Phosphoria formation at Bear Lake Co., Idaho, and Teton Co., Wyoming; Wamsutter, Wyoming: 409; *Stanleya pinnata*, Prince's Plume, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons, Temple Mt., and Marysvale, Utah; Wamsutter, Wyoming: 409.
Sulfur-indicator plants: *Calochortus Nuttallii*, Mariposa lily, found over uranium deposits at Slick Rock, Colorado; Thompsons, Utah; Phosphoria formation, Teton Co., Wyoming: 409; *Eriogonum inflatum*, desert trumpet, found over uranium deposits at Carrizo Mts., Arizona; Thompsons and Temple Mt., Utah; Phosphoria formation at Bear Lake and Caribou Cos., Idaho, and Teton Co., Wyoming: 409; *Lepidium lasciocarpum*, peppergrass, found over uranium deposits at Thompsons, Utah: 409; *Senecio uintahensis*, ragwort, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons, Utah; Phosphoria formation, Caribou Co., Idaho: 409; *Sisymbrium altissimum*, member of the mustard family, found over uranium deposits at Slick Rock, Colorado; Phosphoria formation at Bear Lake and Caribou Cos., Idaho: 409; *Stanleya pinnata*, Prince's Plume, found over uranium deposits at Carrizo Mts., Arizona; Slick Rock, Colorado; Thompsons, Temple Mt., and Marysvale, Utah; Wamsutter, Wyoming: 409.
Geologic Guides—
Application of guides through three stages of drilling: Uravan mineral belt, Colorado: 417.
Associated black or purple fluorite: Marysvale, Utah: 451.
Channel fills: White Canyon, Utah: 401.
Chemical controls: White Canyon, Utah: 401.
Clay zones (argillic alteration): Marysvale, Utah: 451.
Color of mudstone associated with sandstone: Uravan mineral belt, Colorado: 417.
Geologic controls: White Canyon, Utah: 401.
Iron-staining in uranium-bearing veins: Marysvale, Utah: 451.

Ore Criteria—
Features apparently unrelated to ore deposits: conglomerate: White Canyon: Utah: 401; freckled limonite: White Canyon, Utah: 401; hydrous mica: White Canyon, Utah: 401; massive sandstone: White Canyon, Utah: 401; these have served as prospecting guides in other areas but have not been useful in White Canyon, Utah, and are considered unimportant in finding concealed uranium deposits: 401.
Features found in unmineralized as well as mineralized areas: bleaching and alteration of Moenkopi formation: White Canyon, Utah: 401; carbonized wood fragments and vegetal matter: White Canyon, Utah: 401; channel filling: White Canyon, Utah: 401; facies change within Shinarump conglomerate: White Canyon, Utah: 401; favorable prospecting areas may be indicated by association of several features: White Canyon, Utah: 401; fracturing: White Canyon, Utah: 401; iron and manganese staining: White Canyon, Utah: 401; jarosite (?): White Canyon, Utah: 401.
Features found only in mineralized areas: alunite (?): White Canyon, Utah: 401; hydrocarbons: White Canyon, Utah: 401; secondary copper sulfates and carbonates: White Canyon, Utah: 401; sulfide minerals: White Canyon, Utah: 401; visible uranium minerals: White Canyon, Utah: 401.
Presence of carbonaceous material in ore-bearing sandstone: Uravan mineral belt, Colorado: 417.
Radioactive anomalies: Marysvale, Utah: 451.
Rock alteration: Marysvale, Utah: 451.
Structural controls: White Canyon, Utah: 401.
Thickness and color of sandstone beds: Uravan mineral belt, Colorado: 417.
Types of controls—
Chemical controls: White Canyon, Utah: 401.
Geologic controls: White Canyon, Utah: 401.
Relation to channel fills: White Canyon, Utah: 401.
Structural controls: White Canyon, Utah: 401.
Colorado
General—
Geobotanical Guides—
General indicator plants: Slick Rock: 409.
Selenium-indicator plants: Slick Rock, 409.
Sulfur-indicator plants: Slick Rock: 409.
Geologic Guides—
Clays underlying Morrison formation: Calamity Mesa, Mesa Co.: 500; Dynamite mine, Bitter Creek group, Montrose Co.: 500.
Proximity to major tectonic structures: second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed except for a few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks: Coal Creek anticline: 481.
Mesa County—
Geologic Guides—
Clays underlying Morrison formation: Calamity Mesa: 500.
Geologic guides to carnotite deposits—
Altered mudstone association with ore-bearing sandstone: Calamity group, Calamity Mesa: 501.
Numerical evaluation of individual guides: Calamity group, Calamity Mesa: 501.
Presence of abundant carbonaceous material in ore-bearing sandstone: Calamity group, Calamity Mesa: 501.
Thickness and color of ore-bearing sandstone: Calamity group, Calamity Mesa: 501.
Mesa-Montrose-San Miguel Counties—
Geologic guides and their application: Uravan mineral belt: 417.
Montrose County—
Geologic Guides—
Clays underlying Morrison formation: Dynamite mine: 500.
Rio Blanco County—
Geologic Guides—
Proximity to major tectonic structures: second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks, as in Coal Creek anticline: 481.
San Miguel County—
Geobotanical Guides—
General indicator plant: *Purshia tridentata*: Slick Rock: 409.
Selenium-indicator plants: Slick Rock: 409.
Sulfur-indicator plants: Slick Rock: 409.
Colorado Plateau
Geobotanical Guides—
Absorption of ore elements by plants: 409.
Anomalous growth habits in plants: 409.
Effect of chemical environment on plant growth near ore deposits: 409.
General indicator plants: 409.
Plants shown by analyses to have absorbed uranium: 409.
Selenium-indicator plants: 409.
Sulfur-indicator plants: 409.
Geologic Guides—
Bleaching of mudstone: where bleached band of mudstone below Shinarump formation and Salt Wash member of Morrison formation is over one foot thick, in either drill holes or on outcrops, it may be a useful ore guide or indicate strong flows of solutions that may have formed ore deposits: 481; Chinle formation overlying major deposit in Shinarump is bleached to olive-green and serves as a guide to areas in which orebodies may be found and not to orebodies themselves, as shown at Happy Jack mine, Utah: 481.
Bleaching of sandstone: an effective ore guide in La Sal Mts. and Abajo Mts., Utah: 481; chemical changes cause bleach-

URANIUM ORE GUIDES (contd.)
ing of color of sandstone, especially in portions surrounding mineralized area, where bleached zone forms halo around orebodies: 481; not a useful guide where entire formation is bleached and color changes are undetectable as in Henry Mts., Utah, and Carrizo Mts., Arizona: 481; one of the best guides for some areas in the Salt Wash member of the Morrison formation: 481.
Etched and corroded sand grains: this guide has little application since such grains are as difficult to locate as the ore itself, since they accompany the ore: 481.
Geologic guides to carnotite deposits: altered mudstone association with ore-bearing sandstone: 501; numerical evaluation of individual guides: 501; presence of abundant carbonaceous material in ore-bearing sandstone: 501; thickness and color of ore-bearing sandstone: 501.
Guides attributed to post-sedimentation processes: bleaching of mudstone adjacent to sandstone lenses: 481; bleaching of sandstone: 481; etched and corroded sand grains: 481; presence of bleached mudstone pebbles in sandstone lenses: 481; presence of yellow iron-oxide stains: 481; proximity of ore: 481; relation to mountain masses and large folds: 481; this group more useful to prospector than guides attributed to processes of sedimentation and of equal use to geologist directing exploratory drilling of uranium ores: 481.
Guides attributed to process of sedimentation: interfingering of mudstone and sandstone lenses: 481; presence of carbonaceous material: 481; presence of fossil stream channels: 481; thickening of sandstone lenses: 481; this group not as useful to prospector as guides attributed to post-sedimentation processes, but of equal use to geologist directing exploratory drilling of uranium ores: 481.
Interfingering of mudstone and sandstone lenses: Salt Wash member of Morrison formation becomes muddier farther from its source in central Utah, and rich Lukachukai Mts. uranium deposits in Arizona occur where facies change: 481.
Ore-bearing formations: Entrada sandstone: 481; Salt Wash member of Morrison formation: 481; Shinarump formation: 481; recognition of such formations: 481; substitute ore-bearing horizons where usual formations are absent, such as Todilto limestone for Salt Wash member of Morrison formation at Grants, New Mexico, Recapture shales for Salt Wash near Senastee, New Mexico, and at base of Chinle formation and at horizon usually occupied by Shinarump formation at Seven Mile Canyon, Utah: 481.
Ore Criteria—
Features apparently unrelated to ore deposits: conglomerate: White Canyon, Utah: 401; freckled limonite: White Canyon, Utah: 401; hydrous mica: White Canyon, Utah: 401; massive sandstone: White Canyon, Utah: 401; these have served as prospecting guides in other areas but have not been useful in White Canyon and are considered unimportant in finding concealed uranium deposits: 401.
Features found in unmineralized as well as mineralized areas: bleaching and alteration of Moenkopi formation: White Canyon, Utah: 401; carbonized wood fragments and vegetal material: White Canyon, Utah: 401; channel filling: White Canyon, Utah: 401; facies change within Shinarump conglomerate: White Canyon, Utah: 401; fracturing: White Canyon, Utah: 401; iron and manganese staining: White Canyon, Utah: 401; jarosite (?): White Canyon, Utah: 401; favorable prospecting areas may be indicated by association of several features: 401.
Features found only in mineralized areas: alunite (?): White Canyon, Utah: 401; hydrocarbons: White Canyon, Utah: 401; secondary copper sulfates and carbonates: White Canyon, Utah: 401; sulfide minerals: White Canyon, Utah: 401; visible uranium minerals: White Canyon, Utah: 401.
Presence of bleached mudstone pebbles in the sandstone lenses: if mudstone pebbles are red, area is unfavorable for ore: 481; if mudstone pebbles are bleached, ore may or may not be present, so this is an unreliable guide to ore: 481.
Presence of carbonaceous material: uranium deposits in both Shinarump formation and in Salt Wash member of Morrison formation tend to accumulate around contained carbonaceous matter whenever the latter is present, but this guide usually is revealed only during mining progress: 481.
Presence of fossil stream channels: Salt Wash member of Morrison formation, some but not all uranium ore in channels, which are ill-defined in this formation: 481; Shinarump formation, but not all uranium ore occurs in channels nor do all channels contain uranium ore: 481; uranium occurs in channels in Shinarump formation at Happy Jack mine, Utah, and in Monument Valley, Utah and Arizona, in the Monument Nos. 1 and 2, Skyline, and Whirlwind mines: 481.
Presence of limonite or brown rust stains: good ore guide in vicinity of Henry Mts., Utah, and Carrizo Mts., Arizona, where limonite-stained areas may contain ore: 481; where sufficient iron is present to stain outcrops, presence of limonite flecks or pyrite crystals in drill hole cores is good ore guide: 481.
Proximity of ore: drilling recommended where ore is exposed on opposite sides of rim of mesa: 481; drilling should be done directly behind exposure if ore is exposed only on one rim: 481; infrequent ore exposures should suggest drilling only in strip bounded by limits of ore exposures on rim of mesa: 481; where no mineralization appears on the rim of a mesa, drilling

is not recommended regardless of other possibly favorable guides: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around the mountain groups at distances proportional to the mass of the mountains: Abajo Mts., Utah: 481; Henry Mts., Utah: 481; La Sal Mts., Utah: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks: Cane Creek anticline, Utah: 481; Coal Creek anticline, Colorado: 481; Monument Valley uplift and Elk Ridge anticline, Utah and Arizona: 481; San Rafael Swell, Utah: 481; Spanish Valley anticline, NW faulted segment, Utah: 481; Upheaval Dome, Utah: 481; Waterpocket fold, Utah: 481.
Relation to channel fills: White Canyon, Utah: 401.
Structural controls: White Canyon, Utah: 401.
Thickening of sandstone lenses: all large uranium ore deposits in Salt Wash member of Morrison formation occur in thicker parts of sandstone lenses: 481.
Types of uranium ores: uranium-copper ores: 481; uranium-hydrocarbon or thucholite ores: 481; uranium-vanadium ores: 481; uranium in limestone deposits: 481.
Uranium ore usually found in porous carbonaceous sandstone on top of Shinarump siltstone: White Canyon, Utah: 466.

Utah
General—
Geobotanical Guides—
General indicator plants: Marysvale, Temple Mt., Thompsons: 409.
Selenium-indicator plants: Marysvale, Temple Mt., Thompsons: 409.
Sulfur-selenium indicator plants: Marysvale, Temple Mt., Thompsons: 409.
Geologic Guides—
Abundance of carbonaceous material: Blanding District: 465.
Altered mudstone asociated with orebearing sandstone: Blanding District: 465.
Associated black or purple fluorite: Marysvale: 451.
Bleaching of mudstone: in Chinle formation bleaching to olive-green color serves as guide to areas in which orebodies may be found and not to orebodies themselves, as shown at Happy Jack mine: 481.
Bleaching of sandstone: Abajo Mts.: 481; La Sal Mts.: 481; especially useful in certain areas of Salt Wash member of Morrison formation: 481.
Clay zones (argillic alteration): Marysvale: 451.
Interfingering of mudstone and sandstone lenses: Salt Wash member of Morrison formation becomes muddier farther from its source in central part of state: 481.
Iron-staining in uranium-bearing veins: Marysvale: 451.
Ore criteria: White Canyon: 401.
Presence of fossil stream channels: Happy Jack mine in Shinarump formation: 481; Monument Valley in Shinarump formation: 481.
Presence of limonite or brown rust stains: good ore guide in Henry Mts.: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around the mountain groups at distances proportional to the mass of the mountains: Abajo Mts.: 481; Henry Mts.: 481; La Sal Mts.: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks: Cane Creek anticline: 481; Elk Ridge anticline: 481; Monument Valley uplift: 481; San Rafael Swell: 481; Spanish Valley anticline, NW faulted segment: 481; Upheaval Dome: 481; Waterpocket fold: 481.
Radioactive anomalies: Marysvale: 451.
Rock alteration: Marysvale: 451.
Emery County—
Geobotanical Guides—
Analyses of plants growing on uranium-bearing rocks and soils and showing uranium content in ppm. along with vanadium, selenium, and lead content: Temple Mt.: 409.
General indicator plant: *Cowania mexicana*: Temple Mt.: 409.
Selenium-indicator plants: Temple Mt.: 409.
Sulfur-indicator plants: Temple Mt.: 409.
Geologic Guides—
Proximity to major tectonic structures: second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated orebodies at irregular intervals from crest of structure outward to base of its flanks, as in San Rafael Swell: 481.
Garfield County—
Geologic Guides—
Presence of limonite or brown rust stains: Henry Mts.: 481.
Proximity to major tectonic structures: mountain masses with exposed cores of crystalline igneous rock, intruded during Tertiary, and ore deposits forming haloes around mountain groups at distances proportional to the mass of the mountains, as in the Henry Mts.: 481; second type of geologic structure includes large anticlines and domes on which igneous rocks are not exposed, except for a few dikes and volcanic plugs, and ore occurs as isolated ore-

URANIUM ORE GUIDES (contd.)
bodies at irregular intervals from crest of structure outward to base of its flanks, as in the Waterpocket fold: 481.
Grand County—
Geobotanical Guides—
Thompsons District—
Analyses of plants growing on non-mineralized rocks and soils and showing uranium content in ppm. along with vanadium, selenium, molybdenum, and lead content: Dakota sandstone, Harley Dome: 409; Mancos shale E of Thompsons: 409.
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Vanadium Corportion of America (V.C.A.) operations: Durango and Naturita, Colorado, and Hite, Utah, uranium mills: 413, 431. 497, 557.
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Hite: qualified uranium mill operated by V.C.A.: 144, 413, 497, 547.
Monticello: qualified uranium mill owned by U.S.A.E.C. and operated by the Galigher Co.; treats 100 t. carnotite per day: 144, 413, 431, 461, 497, 547, 557; uranium ore sampling plant owned by U.S.A.E.C. and operated by A.S. & R. Co. acting as its sampling and ore buying agents: 461.
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German-Belcher vein: pitchblende produced in commercial quantities from gold- and silver-bearing vein: 467.
Kirk mine: pitchblende: 330.
Kirk vein: pitchblende mined in commercial quantities from gold- and silver-bearing vein: 467.
Wood and Kirk mines: average ore grade 0.2% U_3O_8: 394; producers of over 98% of U_3O_8 in area: 394.
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La Plata County—
Durango: V.C.A. mill: 538; capacity increased: 558.
Mesa County—
Grand Junction: Climax Uranium Co. mill in operation: 73, 431, 497, 557; new uranium processing mill may be built by Vitro Manufacturing Co.: 513, 521.
Mesa-Montrose-San Miguel Counties—
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San Miguel County—
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Colorado—
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Quartz Hill: principal domestic source of pitchblende in area, a recorded 110,757 lbs. of U_3O_8 produced there with average ore grade of 0.2% U_3O_8: 394.
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Vanadium Corporation of America (V.C.A.) operations: Durango, Colorado, uranium mill: 413; Naturita, Colorado, uranium mill: 413; Hite, Utah, small uranium mill: 413.
United States
General: ranks second in world production: 73; for 1911: 330.
Carnotite: ores and concentrates shipped from U.S. mines from 1932–1941: 457; ores from Colorado and Utah, 2 million lbs. U_3O_8, 202 g. radium, from 1913–1923: 415.
Colorado: carnotite: 7; carnotite, pitchblende: 397.
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Salt Lake County—
Salt Lake City: qualified uranium mill (Kalunite plant) of Vitro Chemical Co.: 497, 546; processes Marysvale autunite: 548; processes 100 t. Marysvale ores daily: 547; to process Wyoming ores: 384.
San Juan County—
Hite: qualified uranium mill operated by V.C.A.: 144, 413, 497, 547.
Monticello: qualified uranium mill owned by U.S.A.E.C. and operated by the Galigher Co.; treats 100 t. carnotite per day: 144, 413, 431, 461, 497, 547, 557; uranium ore sampling plant owned by U.S.A.E.C. and operated by A.S. & R. Co. acting as its sampling and ore buying agents: 53, 461.
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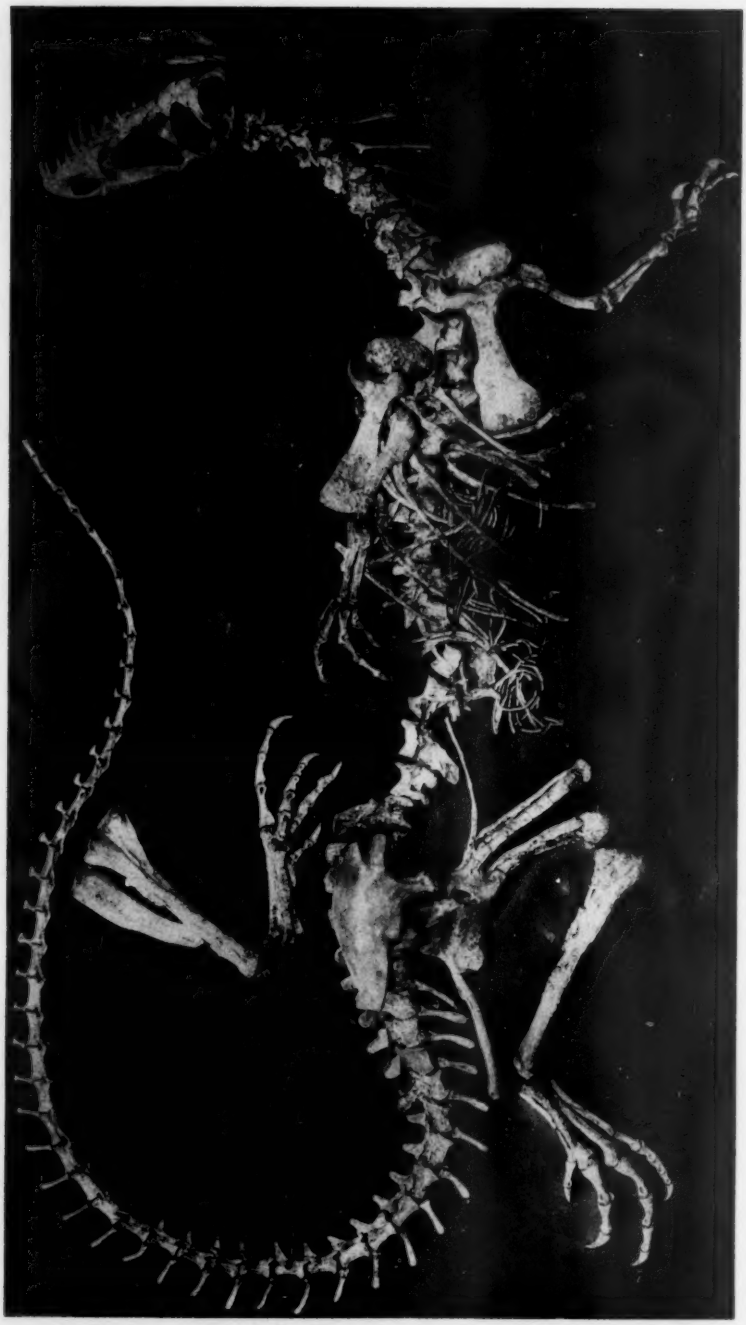

MEGALOSAURUS WETHERILLI, N. SP.

Skeleton as mounted in plaque by Dr. Wann Langston, Jr. Skull and pelvis reconstructed and neck straightened; left hind limb moved up so as to be visible, and tail curved dorsally. Remainder of skeleton in position of burial. Type, U.C.M.P. no. 37302. Right tibia and tibiale measure 60 cm. total length.

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NEW JURASSIC DINOSAUR FROM THE KAYENTA FORMATION OF ARIZONA

BY S. P. WELLES

ABSTRACT

The Kayenta formation overlies the Chinle formation in the Painted Desert of Arizona. The Kayenta contains the earliest American crocodile (*Protosuchus richardsoni* Brown), a new species of megalosaurian dinosaur, and many tracks made by this or a similar species. The dinosaur indicates an Early or Middle Jurassic age for the Kayenta formation at this locality.

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INTRODUCTION AND STRATIGRAPHY

In the summer of 1942 a party from the University of California Museum of Paleontology collected a dinosaur skeleton about 20 miles north of Cameron, near Tuba City in the Navajo Indian Reservation of Arizona. Recent studies by the Navajo Ground Water Project of the U. S. Geological Survey have included the dinosaur-bearing beds, and requests from Mr. Charles A. Repenning for information as to the age of the dinosaur have led to a preliminary study. The results have been unexpectedly decisive and are given here since there is no immediate prospect of a thorough study of the reptile. Ideas presented have been developed in correspondence with Mr. Repenning and in discussions with Professor C. L. Camp. The writer is indebted to Camp and to Professor J. Wyatt Durham for critical reading of the manuscript, and is especially grateful to Mr. Repenning for his many valuable and pertinent suggestions.

The Painted Desert of Arizona, a narrow band of exposures, extends from Navajo Bridge on the north to St. Johns on the southeast; it takes its name from the highly colored continental sediments so magnificently exposed in the area. Near Cameron, 50 miles north of Flagstaff, the rocks dip gently (2°) northeast from the Little Colorado River and comprise, in ascending order, a series of conglomerates; gray shales and sandstones capped by thin but extensive limestones; and a series of cross-bedded brown siltstones, limestones, and bright orange-red sandstones. The conglomerates form the banks of the Little Colorado River at Cameron. The gray shales and sandstones form low flats and haystacklike erosional remnants near the river and the lower cliffs a few miles to the east where the capping limestones are so resistant to erosion that they stand out as the floor of a broad bench called Ward's Terrace. The upper bright orange-red sediments form an eastern part of Ward's Terrace, behind which they rise abruptly to the skyline in the great cliff that marks the western escarpment of the extensive Moenkopi Plateau. These highly colored rocks have long been known to contain dinosaur footprints. They also yielded several skeletons of America's earliest crocodile and the dinosaur skeleton here discussed.

Three distinct, yet interrelated problems confront the stratigrapher in the Painted Desert: (1) the separation and nomenclature

of the rock units; (2) relationship of the faunas; and (3) the correlation and age of the rock units at different localities. This paper considers each problem and presents some new evidence.

The rocks of this region, from Cameron to Tuba City, were intensively studied by Ward (1901; 1905) and again by Gregory (1917). Ward first (1901, p. 405, 412) divided the rocks above the conglomerate into two main groups, the Shinarump below and the Painted Desert beds above. The Shinarump included the conglomerates and overlying shales, marls, mortar beds, and limestones. The conglomerate (800 feet) was named the "Shinarump conglomerate", and the other beds, in ascending order, were the "Variegated marls" (400 feet), sandstones (100 feet), limestone ledge (20 feet), mortar beds (80 feet), and calcareous marls (200 feet) the total thickness of the Shinarump is 1600 feet. The overlying Painted Desert beds comprise, from bottom to top, orange-red sandstone (100 feet) [red-orange sandstone in Ward's table (1901, p. 413)], variegated sandstones (800 feet), brown sandstones (200 feet), and white sandstones (100 feet), a total of 1200 feet.

In 1905 Ward published additional measurements and clarified his terminology although he retained his rock unit names. Thus, while his intensive local studies distinguished several rock units, he did not develop a regional correlation or a regional terminology in customary formational names.

Gregory gave detailed sections of the beds below and above those here considered and also published an excellent geologic map. He called the lower conglomerates the Shinarump conglomerate (thus greatly restricting the term as used by Ward) and used "Chinle formation" for the overlying gray shales and the basal member of Ward's Painted Desert formation. Ward's overlying "variegated sandstones" and "brown sandstone" and "white sandstone" Gregory tentatively placed in the La Plata group and McElmo formation. In the La Plata group he recognized the Wingate[1] formation, the Todilto formation, and the Navajo formation. Later work by Baker, Dane, and McKnight (1931) substituted Kayenta for Todilto in this region, making the succession the Wingate, Kayenta, and Navajo formations. Gregory's tentative assignment of these three formations to the La Plata group was not corroborated by subsequent work, and Baker, Dobbin, McKnight, and Reeside, Jr., (1927, p. 802) substituted the name Glen Canyon group, taken from the manuscript of Gregory and Moore (1931, p. 61) for La Plata group.

Colbert and Mook (1951, p. 151) proposed the name "Dinosaur Canyon sandstone" for the 200 feet of rocks above Ward's Terrace, including the dinosaur- and crocodile-bearing beds, which were considered distinct from the Chinle, the "Wingate," and Kayenta, although there were "cogent reasons for associating them either with the Chinle formation below or the supposed Jurassic above". However, these authors cite preliminary work by Mr. Joseph Callahan calling the *Protosuchus* beds "Kayenta type" lithology.

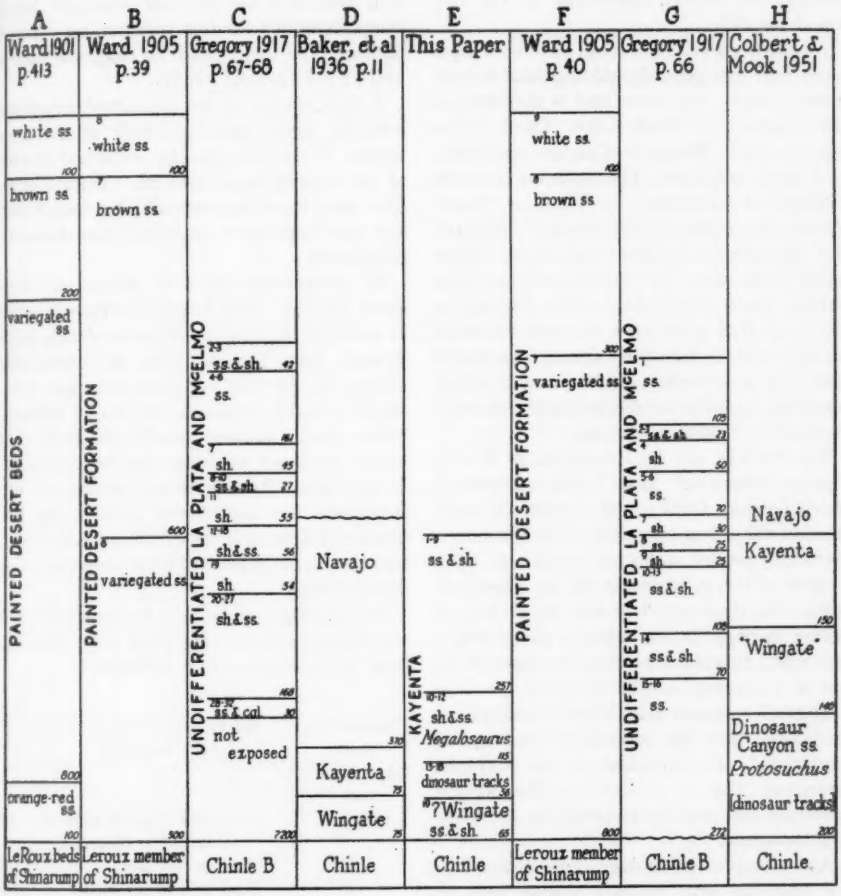
Our problem is to apply acceptable regional terminology to these local rock units and to unite them into natural groups. Our difficulties center around the "orange-red sandstone," which Ward (1901 p. 411) placed in the Painted Desert formation along with the overlying rocks; which Gregory (1917, p. 47)[2] called Chinle A and included with the lower rocks; and which Colbert and Mook named "Dinosaur Canyon sandstone" and separated from the Chinle but did not definitely group with the upper rocks.

The lithology of this Glen Canyon group at Tuba City has been described by previous workers, and the writer made additional notes when, in 1941, with Dr. F. E. Peabody, he collected a headless *Protosuchus* skeleton at the type locality. The sand at the *Protosuchus* locality is orange red ("moderate reddish brown, hue 10, chroma R and lightness ½" in

[1] The type of the Wingate formation was defined by Dutton in 1885 (Figs. 1, 2; Pl. 16) with the type section at Fort Wingate. The writer is strongly opposed to the attempt by Baker, Dane, and Reeside to substitute the name Entrada for the type Wingate and then steal the name Wingate for Utah rocks of another age. As Colbert pointed out (Colbert and Mook, 1951, p. 153) this would destroy the stability of stratigraphic nomenclature.

[2] This does not necessarily indicate that the Chinle A at the type section is also equivalent to the Dinosaur Canyon sandstone of the Kayenta, but it does raise this most interesting question.

TABLE 1.—COLUMNAR SECTIONS THROUGH THE GLEN CANYON GROUP AT TUBA CITY *Megalosaurus* LOCALITY (A-E) AND AT DINOSAUR CANYON *Protosuchus* LOCALITY (F-H)



terms of the National Research Council rock color chart according to Colbert), uniformly fine-grained, and highly wedge-bedded. It has bluish streaks and contains many bluish spheres. The *Protosuchus* level is a sandstone about 40 feet thick which is divided into crossbedded members by horizontal planes. These thinner members are about 5 feet thick and show bluish mottling and banding. This seems to be an upper phase that is continued and repeated in the cliff above, although the cliff face was not examined closely. These beds weather into blocky masses, pinnacles, and monuments. They probably represent bed 16 of the writer's section at the dinosaur locality, but in such lenticular and locally variable beds the correlation is only approximate.

Below this cross-bedded sandy phase is 30 feet of mud-cracked, essentially horizontal shale. The mud cracks are filled by a more resistant bluish, limy mudstone that stands out in relief on a weathered section. The dinosaur tracks that give the name to Dinosaur Canyon are on gray sandstone or limy sandstone and mudstone lenses in these shales. The lowest occurrence of the orange-red lenses is about

150 feet above the Chinle (85 feet at the dinosaur locality), and they recur many times up through the section, apparently to the very top of the cliff.

As noted above, these rocks have been separated into two generally distinguishable sedimentary units. The lower unit is the "orange-red sandstone" of Ward, called "Chinle A" by Gregory and "Dinosaur Canyon sandstone" by Colbert and Mook. The upper unit includes "variegated sandstones" of Ward or "undifferentiated La Plata" of Gregory or " 'Wingate' and Kayenta" of Colbert and Mook. These units grade into one another without any obvious break in deposition. The lithology is similar to that of the type Kayenta formation (as also noted by Callahan) although somewhat finer and considerably thicker, and it differs markedly from the massive eolian cross-bedded Wingate or Navajo sandstones.

The Navajo can be recognized in Ward's "brown sandstone" and "white sandstone" which Gregory (1917, p. 68) tentatively identified at the top of his section. The Wingate is doubtfully present in this region although, since Gregory (1917, p. 54) wrote "in the Moenkopi region the thickness decreases to 30 feet at Willow Springs" [a few miles to the north], a case might be made for calling the lower 65–75 feet of the writer's section Wingate.[3]

This all indicates that Ward's "orange-red sandstone" plus the superjacent "variegated sandstones" are equivalent to the Kayenta formation. This is overlain by the Navajo sandstone and possibly underlain by the Wingate sandstone.

A reasonable terminology could thus place the crocodile- and dinosaur-bearing beds in the Kayenta formation, with the possible correlation of some of the basal sandstones with the Wingate. The name Dinosaur Canyon sandstone is quite appropriate when applied to a member of the Kayenta formation, but a sharp definition of this member may prove difficult. The writer failed to recognize such a unit at the dinosaur locality.

A final solution of the stratigraphic problem must be based upon a restudy of the type section of the Wingate and an actual tracing of the type Wingate into the Cameron area. The type Kayenta must also be traced out, and only thus can stratigraphic boundaries be established.

In southwestern Nevada Muller and Ferguson (1939, p. 1610) found a continuous series of conformable marine sediments dating from Triassic into Jurassic with no perceptible change in lithology. A boundary was arbitrarily selected within the 30 feet of unfossiliferous shales between fossiliferous beds that could be dated by their faunas. Similarly, in the Tuba City continental section, no unconformity has been found between the undoubted Triassic and the overlying rocks. Here, too, the faunas seem to be the only means of dating the beds.

The lithologic sequence as measured through the dinosaur locality near Tuba City, Arizona, from the top downward is as follows:

		Feet
? Navajo sandstone	Heavy cross-bedded white or gray sandstone	20
Kayenta formation		
Unit 1	Sandstone topping cliff at phone line to Moa Ave.	10
2	Shale in cliff face	20
3	Sandstone in cliff face	5
4	Shale in cliff face	15
5	Gray sandstone in cliff face	5
6	Cliff—no apparent difference in color except near top where orange-red recurs. Banded shale and sandstone. Brown, gray, purple brown	155
7	Orange-red sandstone, shale and some gray shale, limy sandstone at top forms bench	35
8	Alternating dark-red and light-gray shale	20
9	White sandstone weathers	2

[3] Since the above was written, A. A. Waneck and J. G. Stephens have published their *Reconnaissance geologic map of the Kaibito and Moenkepi Plateaus and parts of the Painted Desert, Coconino County, Arizona* (U. S. Geol. Survey, Oil and Gas Invest, Map OM 145, 2 sheets). They map a broad band of Wingate which includes the dinousaur locality and indicate (sheet 2, graphic section I) that the Wingate is 330 feet thick at Tuba City. Since *Megalosaurus wetherilli* was collected 126 feet above the Chinle, it obviously occurs in beds that Waneck and Stephens identify as Wingate. This emphasizes the critical need for tracing the Kayenta and Wingate formations from their type sections into this region. Only thus can accurate terminology be established.

	out into small spheres, forms bench	
10	Shale covered by recent sand dunes but exposed to south	45
11	Purplish blocky shale with some sandstone	65
12	Purplish blocky shale with skeleton of *Megalosaurus wetherilli*	5
13	Gray limy sandstone	1
14	Massive gray dune sandstone, finely cross-bedded. Tuba City—Moa Ave. road and fence	15
15	Gray sandstone and reddish shale. Dinosaur tracks in sandstone	10
16	Massive dune - bedded orange - red sandstone, forms monuments locally. Horizon of *Protosuchus richardsoni* Brown, found about 10 miles to southeast	10
17	Gray sandstone and orange-red shale	10
18	10 feet gray sandstone	10
19	65 feet orange-red and yellow-brown sandstone and red-brown shale, the shale in many places mud-cracked and cracks filled with gray sandstone. Possibly Wingate	65
Chinle formation	Upper Chinle, purplish-gray and buff limestones, mudstones, shale, and marl. Some gray sandstone and sandy limestone, and limestone conglomerate and bone. Top is a 3-foot sandy limestone that forms a lower terrace	

? Dinosaur Canyon sandstone

Dinosaur Skeleton

The material consists of a nearly complete skeleton and parts of a second, from which the first has been restored. Collection was by the writer, Mr. W. H. Rush, and Dr. H. E. Cott. Preliminary preparation was under the writer's supervision, but final preparation was supervised by Dr. Wann Langston, Jr., who made a splendid plaque mount of the specimen. Comparison with other described dinosaurs indicates that the material represents a new species.

Megalosaurus wetherilli,[4] n. sp.

Type.—A nearly complete skeleton, U.C.M.P. no. 37302.

Hypodigm.—Type and partial skeleton collected 10 feet from type, U.C.M.P. no. 37303.

Locality.—U.C.M.P. V4214, in center of flat valley of purplish blocky shale about 200 yards northeast of road fence, 1.3 miles northwest of Cameron-Tuba City highway on old road to Moenave. SW ¼, Sec. 34, T. 32 N., R. 10 E., Coconino Co., Arizona Highway Planning Survey Map. On bench north of Moenkopi Wash below Tuba City, equivalent to Ward's Terrace to the south.

Horizon.—126 feet above the Chinle in beds thought to be referable to the Kayenta formation, and of Early Jurassic age.

Diagnosis.—A megalosaur with relatively longer forelimbs than *M. bucklandi* or *M. cuvieri* Owen, and nearer to these in limb proportions than to other known forms. Tibia relatively longer than in other megalosaurs, nearly equal to femur (for measurements and proportions *see* Table 1). Astragalus with well-developed processus ascendens.

Discussion.—The above preliminary diagnosis is intended merely to distinguish the species and validate the name proposed here so that the material can be readily referred to.

Carnivorous dinosaurs, all of which are placed in the suborder Theropoda, arose from pseudosuchian ancestors in the late Triassic. They continued to expand and diversify, and became the dominant predators of the Jurassic and Cretaceous. Throughout this long life span many changes occurred in the structure of the skeleton. Some of these changes were proportional and progressive, and have been

[4] Named in honor of the late John Wetherill of Kayenta, explorer, friend of scientists, and trusted trader and counselor to the Navaho, whose nephew, Milton, first told us of the specimen.

TABLE 2.—SKELETAL INDICES OF MEGALOSAUROIDEA (Data from Huene, 1932, p. 326) unless otherwise noted; estimates italicized)

			1	2	3	4	5	6	7	8	9
			$\frac{H + R + McIII}{F + T + MtIII}$	Total in cm.	Index	H/F Index	R/H	T/F	McIII/T	MtIII/F	ΣD
Upper Cretaceous		*Tyrannosaurus rex* Osborn	$\frac{26 + 18.5 + 9}{135 + 116 + 66}$	$\frac{53.5}{349}$	15	19	71	88	57	49	88
		Gorgosaurus libratus Lambe	$\frac{33 + 16 + \textit{10}}{104 + 100 + 59}$	$\frac{58}{263}$	22	31	48	96	59	57	61
Upper Jurassic		*Ceratosaurus nasicornis* Marsh. From Gilmore, 1920	$\frac{\textit{21} + 15 + 7}{62 + 56 + 25}$	$\frac{43}{143}$	30	34	71	90	45	40	70
		Antrodemus valens Leidy. U.S.N.M. No. 4734. From Gilmore, 1920	$\frac{31 + 22 + \textit{10}}{85 + 69 + 33}$	$\frac{62}{187}$	33	37	71	81	48	39	72
		Megalosaurus cuvieri Owen	$\frac{24 + 14 + \textit{7}}{52 + 50 + 24}$	$\frac{45}{126}$	36	46	58	96	48	46	32
Middle Jurassic		*Megalosaurus bucklandi* Meyer	$\frac{38 + 21 + 10}{70 + 65 + 39}$	$\frac{69}{174}$	40	54	55	93	60	56	22
Lower Jurassic		*Megalosaurus wetherilli* Welles. Original data	$\frac{28 + 17.5 + 10}{54 + 53 + 29}$	$\frac{55.5}{136}$	41	52	62	98	55	54	—
Upper Triassic	Knollen mergel	*Pachysaurus wetzelianus* Huene. Type	$\frac{55 + 31 + \textit{19}}{98 + 80 + 36}$	$\frac{105}{214}$	49	56	56	82	45	37	61
		P. reinigeri Huene. Type	$\frac{40 + \textit{23} + \textit{11}}{63 + 51 + 22}$	$\frac{74}{136}$	54	64	58	81	43	35	77
	Red Beds	*Gryponyx africanus* Broom	$\frac{\textit{34} + 21 + 7}{54 + 45 + 20}$	$\frac{62}{119}$	52	63	62	83	44	37	65
	Stuben sandstein	*Teratosaurus minor* Huene. Stuttgart, No. 1284?	$\frac{33 + 15 + 9}{54 + 46 + 21}$	$\frac{57}{121}$	47	61	45	85	46	39	69
		T. suevicus Meyer. *cf.* Huene, 1915	$\frac{47 + \textit{21} + \textit{13}}{74 + \textit{63} + 28}$	$\frac{81}{165}$	49	64	45	85	44	38	77
		Palaeosaurus (?) *diagnosticus* Huene. Stuttgart, No. 12667	$\frac{17 + 10 + 5}{24 + 22 + \textit{10}}$	$\frac{32}{56}$	57	71	59	92	45	42	66

In Column 1, the numerator consists of the measurements of humerus, radius, and metacarpal III, and the denominator the measurements of femur, tibia, and metatarsal III (in cm) (estimates are italicized). To facilitate the comparison of absolute size of the various megalosaurs Column 2 lists the totals of these three figures. These totals are considered to represent the effective length of forelimb and hindlimb respectively. Column 3 contains indices of effective fore limb to effective hind limb (Quotient Column 2 × 100), while Columns 4 to 8 are indices of humerus: femur, radius: humerus, tibia: femur, metarsal III: tibia, and metatarsal III: femur. Column 9 shows the total amount, regardless of sign, that the indices of comparable theropods differ from those of *Megalosaurus wetherilli*.

noted and analyzed by previous workers; Gilmore (1920, p. 144) and Huene (1932, p. 347) present rather imposing lists. One of the most obvious progressive changes is the proportional shortening of the fore limb and lengthening of the hind limb. Huene's monograph assembled measurements and indices of relative limb length for all known theropods. It was therefore a simple matter to measure the skeletal elements of *Megalosaurus wetherilli*, compute indices, and fit them into Huene's tables. This "slide-rule" method of identification is definitely preliminary to a careful morphologic study, but the writer knows of no osteological features which contradict the results indicated by the indices.

The indices of columns 3 to 8 (Table 2) indicate the relative proportions of various parts of the limbs of the known megalosaurs. The nearer the indices of any two forms, the nearer are the proportions indicated. In animals of comparable size and in a closely related group we might logically assume that phyletic relationship is a direct correlative of proportional similarity. Furthermore, where progressive changes occur throughout geologic time, the column of indices becomes a practical time scale.

Comparative measurements are available for only a few of the supra-Triassic megalosaurs, yet with these arranged stratigraphically there is an amazingly uniform decrease in the fore limb : hind limb ratio. There is also a remarkable nearly lineal progression in the other indices, which leaves little doubt as to the relative position of the Tuba City megalosaur in this table.

Simple inspection of columns 3 to 8 indicates that *M. wetherilli* is very close to *M. bucklandi* Meyer of the middle Jurassic of Europe and to *M. cuvieri* Owen of the late Jurassic of Europe. It is much closer to these than to any of the European Late Triassic forms and therefore is indicative of Early, or even Middle Jurassic age rather than Late Triassic age.

In column 9 are listed the total of all differences of the indices of the other megalosaurs from the indices of *M. wetherilli*. These differences are by simple subtraction, without regard to sign. Therefore, a similarly proportioned reptile would have a small total of differences. Column 9 accentuates the relationships indicated by inspection of the rest of the table, and it is clear that the Tuba City form differs less from the known species of the genus *Megalosaurus* than from other known forms. The differences are much less than from either Late Triassic or other Late Jurassic megalosaurs. Here again the most logical age would be Early Jurassic, with an indication of later rather than earlier age.

M. wetherilli differs slightly from the previously described species in having an exceptionally long tibia, but otherwise it agrees very well with other members of the genus.

A simple osteologic character of significance in determination of geologic age pointed out by Gilmore (1920, p. 145) and by D. M. S. Watson (Personal Communication) is the growth of the ascending process of the astragalus. This process is incipient in the Triassic theropods, intermediate in the Morrison forms, and quite large in the late Cretaceous animals. The ascending process of the astragalus in *M. wetherilli* is well developed and represents a stage considerably more advanced than in the known late Triassic theropods. This, then, corroborates the evidence from the indices as to the geologic age of the specimens.

Age of the Beds

The age of the rocks should be a problem quite distinct from the stratigraphy, yet there is much confusion of thought in this respect. Camp (1930, p. 3) collected extensively in the Chinle formation and grouped Gregory's C and D into the Lower Chinle, the A and B into the Upper Chinle, each with distinct faunas. He correlated the Lower Chinle faunas with those of the lower Upper Triassic (Lettenkohle), while the Upper Chinle faunas, principally from Utah and northern New Mexico, were considered late Late Triassic (Keuper) in age. This was a clear-cut correlation of faunas from certain levels and localities, and nowhere did it imply that time and lithologic, or faunal and lithologic, boundaries must coincide. The writer therefore believes that Heaton (1950, p. 1681) went beyond the evidence and failed to distinguish among time, faunal, and lithologic units when he placed the Wingate formation (and Kayenta formation) in the Triassic

because "it loses its identity, becomes more shaly, and merges into Upper Triassic beds east." Chinle lithology does not everywhere prove Late Triassic age.

As shown in Table 1, the beds immediately above the Chinle formation contain dinosaur tracks, several skeletons of America's earliest crocodile, *Protosuchus richardsoni* Brown, and dinosaur skeletons. Our only means of dating the rocks is through these fossil vertebrates (some invertebrates are known but are not conclusive). The dinosaur tracks are tridactyl and bipedal, and those in the section measure 23 cm from heel to tip of third toe and have a pace of about 1 meter. C. L. Camp and the writer have also seen such tracks near Zion Canyon, at Pipe Springs, Kanab, and Kayenta in rocks of similar lithology and presumably equivalent age. Gregory (1917, p. 56) collected similar tracks from Navajo Canyon (1917, Pl. 9 C) and Willow Springs. These were submitted to Lull who compared them with tracks from the Connecticut Valley and concluded (Gregory, 1917, p. 56), on size alone, that the Kayenta tracks were younger. Baker (1946, p. 67) found similar tracks in "the transition zone between the Kayenta and Navajo in rocks that were mapped as Navajo but might equally well have been considered Kayenta." His locality was on Iron Wash near the San Rafael Swell. The tracks were examined by Gilmore who evidently made no comment on their age.

The careful study of *Protosuchus* by Colbert and Mook (1951) showed that it is of little stratigraphic importance and could be either Triassic or Jurassic. The preliminary study of the dinosaur places it in the Early or Early Middle Jurassic. Evidence to date thus indicates that in this region the Chinle formation is Upper Triassic and the Kayenta formation Lower or Middle Jurassic.

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